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TAXONOMIC AND BIOLOGICAL STUDIES OF MITES OF THE GENUS ARCTOSEIUS THOR FROM BARROW, ALASKA (ACARINA: ACEOSEJIDAE)[1]

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INTRODUCTION

MITES of the genus *Arctoseius* Thor, like many other aceosejids, are encountered frequently in soil and humus. Their description and identification are important to the study of soil ecology. Ecological information dealing with such biotic factors of the soil is of little value until the taxonomy of each group of organisms is known. Our knowledge concerning the taxonomy of *Arctoseius* mites is incomplete, and almost no information about the ecology of these mites exists in the literature.

This paper is primarily a taxonomic study of the genus *Arctoseius* at Barrow, Alaska. Because of the manner in which the extensive collections of soil arthropods were made from that area, some ecological and other biological characteristics of the species of *Arctoseius* involved became evident and are discussed.

To a considerable extent, the arthropod fauna of arctic areas is composed of widely distributed forms that range northward from, or southward to, more temperate latitudes. Although some of these forms exist only in the alpine zones of higher mountainous areas of temperate regions, others are more widespread and range through the intervening lowlands. Thus, there is the possibility that the species of *Arctoseius* discussed in this paper, although known at present to exist only in arctic Alaska, may be components of the arthropod fauna of soils of more temperate regions of North America, including California.

That these species collected from Barrow are not known to exist in any other areas, arctic or temperate, points to the infrequency of collecting soil mites and to the resultant paucity of knowledge concerning them. A closely related example, *Arctoseius cetratus* (Sellnick) has been known to science for the past twenty years. In the literature of that period, various workers had recorded it from Iceland, England, and central and northern continental Europe; but almost nothing has been written about its habits as a living organism. *A. cetratus* has been collected from various parts of the United

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States, including California, and from a variety of environmental conditions that include farm- and rangeland soils, yet it has never been recorded in the literature as occurring in North America.

More than sixty species of terrestrial mites are known to occur in the vicinity of Barrow, Alaska (Hurd, 1958; Hurd, Britton, and Pitelka, in manuscript). These are distributed among some fifty genera in thirty-two families. Only the genus *Arctoseius* is represented there by more than two species. Moreover, members of this genus constitute the most dominant group of Mesostigmata in that area, from the standpoint of numbers of individuals.

Knowledge of the occurrence of *Arctoseius* near Barrow has been based on a few females collected by Weber in 1950. Evans (1955) described three new species on the basis of these specimens. From the extensive collections made by Hurd, Britton, and Pitelka in the summer of 1953, seven species, four of which are new to science, are recognized in the present paper. Both sexes of all seven species are described, and the importance of males for species recognition is demonstrated. The collections are accompanied by descriptions of the various sites which were sampled. These data, restricted to the warmest three months of an entire year at this arctic locality, have been examined to gather as much ecological and other biological information as possible concerning species of *Arctoseius* in the Barrow area.

It is hoped that the taxonomic and supplementary studies of species of *Arctoseius* in this paper will form a framework upon which more detailed biological work on these mites as living organisms can be based. Low temperatures and a short growing season are the chief limiting factors that restrict the complexity of ecological interrelationships of an arctic biota as well as the variety and number of species comprising this biota. Such a biota with its dynamics, although complex in absolute terms, has a relative simplicity that offers unusual opportunities for research.

Ecological and other biological information that can be acquired more readily in such arctic areas is applicable in large part to the understanding of the species involved in other areas of their occurrence, even when these are temperate areas with much more inherent ecological complexity. Climatic factors have important effects on the biology of insects, mites, and their arthropod enemies. Research on these factors is a part of the program of investigations dealing with the control of insects and mites which are damaging to crops in California. Studies concerning climatic limiting factors can be conducted to a considerable extent in a representative variety of the natural environments of insects and mites. For example, it is indicated in this paper that *Arctoseius* mites, probably as adults, must tolerate a wide range of temperatures, including extremely low ones, during the year in order to exist at Barrow. Thus, it might be expected that the presence of low temperatures in other areas probably would not function as an environmental factor that would limit the distribution and abundance of these mites.

MATERIALS AND METHODS

The Arctic Research Laboratory is located between the village of Barrow and the geographic landmark, Point Barrow, on the northern arctic coast of Alaska. Field work, including Berlese extractions of soil samples, was con-

ducted by Hurd, Britton, and Pitelka during the summers of 1952 and 1953 about one mile southwest of the Laboratory. The field work and use of the facilities of the Laboratory were made possible by support from the Arctic Institute of North America and the Office of Naval Research.

The materials available for the present study were restricted to the 1953 Berlese extractions and were collected from June 22 through August 25, 1953, by Hurd and Britton. During this time, over 500 Berlese extractions representing most of the local habitat types were made. Samples were taken from six field stations and from other miscellaneous habitats.

Sample cores were taken from surface vegetation and substrate soil to a depth of 10 cm. At station I, the cores were 25 cm in diameter and were subjected to extraction by Berlese funnels for 12 hours. At the other stations, the cores were 15 cm in diameter and the extraction period was 24 hours. The extracted material was collected and preserved in 95 per cent ethyl alcohol and placed in 8- × 90-mm flat-bottomed shell vials for storage.

From 16 to 19 samples, approximately 1 every 3 days, were taken at each site of stations II through VI. From the series of samples taken at these stations, early (June 29–30) and late (August 17–18) sub-series totaling 55 samples were selected and subjected to quantitative and qualitative examination for *Arctoseius* mites. In addition, over 70 samples collected in July and August from these same stations were examined qualitatively, and 10 of these quantitatively. In the case of station I, where only an early series of samples was taken, all 9 samples were examined both qualitatively and quantitatively.

During the course of this study, hundreds of individuals of species of *Arctoseius* were mounted in Hoyer's medium on microslides, to obtain type and reference specimens, and for the purpose of quick routine identification. All holotypes and allotypes of the new species of *Arctoseius* described herein are on microslides and have been deposited in the United States National Museum, Washington, D.C. Supplementary neallotypes of males and plesiotypes of females representing those species of *Arctoseius* which have been described by Evans (1955) only on the basis of females are also on deposit in the United States National Museum. In addition, paratype and plesiotype specimens, representing all of the species of *Arctoseius* presently known from Barrow, have been deposited both in the California Insect Survey, University of California, Berkeley, and in the British Museum (Natural History), London.

Methods used in the measurement of body structures of the mites, as well as chaetotaxic nomenclature, are discussed in the section on systematics.

PHYSICAL FEATURES OF THE BARROW AREA

Barrow is located at 71° 20′ north latitude, about ten miles southwest of Point Barrow, the northernmost projection of Alaska and the second most northern projection of continental North America. The Barrow area lies in the northern extremity of that physiographic province of the Alaskan arctic slope known as the Arctic Coastal Plain. Topographically, the land around Barrow is extremely low and flat with poorly developed surface drainage. The most elevated land in the area lying between Barrow and Point Barrow

is no greater than twenty feet above sea level. Topographic relief around Barrow is usually less than five feet, from a swampy depression to the crest of surrounding mounds and ridges. Shallow ponds, lakes, and swamps are curiously parallel in orientation and monotonously dent the plain. The land is further patterned with reticulations caused by ice-wedge polygon formations.

According to Britton (1957), the climate over the Alaskan arctic slope is severe, ". . . characterized by long cold winters, and short cool summers with frequent heavy fog and cloud cover, scanty precipitation, high humidity,

TABLE 1

MISCELLANEOUS TEMPERATURE INFORMATION, BARROW, ALASKA, 1953

Month	Mean monthly maximum	Mean monthly minimum	Monthly mean	Departure from long term monthly means	Range		Number of days			
					Low	High	Max. 50° or above	Max. 32° or below	Min. 32° or below	Min. 0° or below
January	−10.7	−22.7	−16.7	−1.6	+6	−42	0	31	31	30
February	−16.0	−25.6	−20.8	−2.9	−1	−43	0	28	28	28
March	−10.0	−22.4	−16.2	−1.3	+4	−40	0	31	31	31
April	+10.3	−5.3	+2.5	+2.7	+25	−29	0	30	30	21
May	+25.4	+14.8	+20.1	+1.3	+35	−1	0	28	31	1
June	+38.8	+30.2	+34.5	+0.6	+51	+26	2	0	27	0
July	+44.0	+32.0	+38.0	−1.7	+67	+27	7	0	21	0
August	+38.5	+30.3	+34.4	−4.0	+55	+24	4	3	27	0
September	+34.2	+27.1	+30.7	+0.1	+51	+20	1	15	25	0
October	+13.5	+4.0	+8.8	−8.3	+27	−15	0	31	31	12
November	+6.5	−8.8	−1.2	−1.9	+28	−29	0	30	30	23
December	−11.9	−22.1	−17.0	−6.6	−2	−35	0	31	31	31
Year	+13.6	+2.6	+8.1	−2.0	+67	−43	14	258	343	177

Source: United States Weather Bureau, *Climatological Data, Alaska* 39(1–13): 1–183.

and persistent winds." During most of the year, temperatures remain below freezing. He states, for example, that the United States Weather Bureau's local climatological data from Barrow indicate, on the average, maximum tempertures exceeding 32°F. on only 111 days, and minimum temperatures falling below 32°F. on 323 days of the year. Only during the period of June through August are mean temperatures above freezing at Barrow, and it was during this period in 1953 that Hurd and Britton collected the Berlese samples containing *Arctoseius* mites that were used in the present study. As an example of the annual cycle of temperature conditions which occur at Barrow, table 1 presents local climatological data compiled by the United States Weather Bureau for 1953.

From data like those in table 1, collected since 1912 at Barrow by the United States Weather Bureau, the general annual temperature fluctuations are well established. The annual mean temperature is about 10°F., and the absolute maximum and minimum temperatures recorded are +78°F. and −56°F., respectively. Maximum daily temperatures begin to climb above freezing in late May and early June, and continue to do so almost to the

end of September. But minimum daily temperatures may drop below freezing anytime during the summer, even at the vegetational level, according to Britton (1957). For the year 1953, table 1 shows that only 22 days of the entire year had temperatures wholly above 32°F., with nearly half of these days occurring in July.

Britton (1957) states that during most of the growing season heavy fog and cloud cover occur, preventing sunny days, with a 24-hour potential of sunshine, from being frequent. The warmest month during the growing season is July, yet this is also the month with greatest fog cover at Barrow.

Although Weather Bureau precipitation records for Barrow indicate low values, the mean annual precipitation being only 4.1 inches, this amount appears to be too low to account for the degree of soil saturation, according to Britton. The concept of arctic climates being arid perhaps does not apply to Barrow and other areas of the Arctic Slope. Britton cites recent studies which tend to show that large water deficits do not occur on the tundra surfaces, and that precipitation exceeds evapotranspiration by small amounts, at least during the growing season.

Britton makes clear the importance of snowfall as an ecological factor, even though the mean annual snowfall at Barrow is only 26.2 inches. Snow provides a mantle over vegetation, protecting it from the cold temperature extremes of the air above. Snow also provides an abundant source of water which saturates the ground in early summer. In areas of greater accumulation, snow shortens the growing season of plants below. There may be intermittent snowfall at any time of the year at Barrow, and snow accumulation on the ground is definitely under way in October.

The vegetation around Barrow is, of course, that of a tundra. Although treeless, the terrain is well mantled with grasses and grass-like vascular plants, mosses, and lichens (see Britton, 1957).

DESCRIPTION OF COLLECTING SITES

A brief description of the topographical, vegetational, and substrate characteristics of the six field stations and their sites follows. These descriptions are based on information received from Dr. M. E. Britton (personal correspondence).

Station I

Station I was an area of initial exploratory sampling, and the included nine sites did not lie serially along any particular environmental gradient. The sites were sampled only once early in the summer, June 22, and were not included in subsequent collecting activities.

Sites 1, 2, and 4: On the flat bottom of a shallow, naturally drained thaw-pond, the surface covered with close-growing mosses and sparse *Carex* and *Dupontia;* substrate highly organic with dense roots and rhizomes.

Site 3: On a slightly elevated mound in the same area as sites 1, 2, and 4; with sparse cover of mosses.

Sites 5 and 6: On top of a polygon mound covered with lichens; in addition, dead *Poa* and *Luzula* in site 5, and sparse *Potentilla* and graminoid species in site 6; substrate largely organic with fine sand in site 5, and mostly silt with scattered coarse sand in site 6.

Site 7: At the base of polygon mound of sites 5 and 6, just above the juncture of mound and its associated trough; a dense mat of mosses with scattered graminoid species covered a fibrous-peaty substrate of partially decayed moss.

Site 8: Near site 7, in the bottom of the trough; sample almost purely organic, filled with graminoid roots and rhizomes.

Site 9: "Frost boil" on top of a polygon mound; no apparent organic material in silt substrate but a thin scattering of dead *Carex* leaves on the surface.

Station II

Station II consisted of a series of eight sites associated with a small thaw-pond, and was situated along an environmental gradient in which variation of soil conditions, especially drainage, appeared to be significant. The entire sequence extended over a distance of about 65 feet from wetter sites on the pond margin to drier sites on tops of hummocks.

Site 8:[1] Submerged in the pond most of the summer season; vegetation a dense mixture of *Arctophila, Eriophorum,* and *Carex;* substrate of coarse raw organic debris with mass of rhizomes and roots, but grading to more finely divided organic material with increasing depth.

Site 1: Near high water level of pond and saturated at all times; vegetation grading from *Eriophorum* and *Carex* to *Dupontia;* substrate similar to that of site 8.

Site 2: At slightly higher elevation than site 1; substrate always saturated, and water over surface at times; vegetation mostly *Dupontia* with some *Carex;* substrate largely organic and coarse-textured throughout with dense mass of roots and rhizomes, and with scattered lenses of coarse sand.

Site 3: Similar to site 2 but at slightly higher elevation; rarely or never covered by water, but substrate always saturated; ground cover of liverworts and some moss in addition to *Dupontia.*

Site 4: About 3 or 4 feet from peat hummocks forming the boundary of thaw-pond area, and thus still on the flat of the pond area, but slightly higher than site 3; substrate always wet but only saturated at intervals; *Dupontia* cover less dense than site 3, but a dense moss cover present; upper half of substrate, brown peat with dense root mass; lower half of substrate, black peat with finer fibrous organic matter.

Site 5: At base of slope rising abruptly out of swamp to marginal peat hummocks; substrate, moist to wet; vegetation of scattered *Carex* on well developed moss stratum overgrown in places by fructicose lichens; substrate almost entirely organic moss-peat with some scattered sand.

Site 6: On top of peat hummock or polygon ridge at edge of swamp; substrate moist but not wet except at time of thaw, and subject to considerable surface drying; dense cover of fructicose lichens and some mosses and about 30 per cent cover of *Luzula, Poa,* and *Carex;* upper third of substrate, black peat mixed with coarse, wind-blown sand; lower two-thirds of substrate, coarse brown peat with large proportion of intact plant fragments and with little or no sand.

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[1] Hurd and Britton's original numbering of sites is retained in the present work. Although site 8 was the first of the series grading from wetter to drier conditions, it was sampled infrequently.

Site 7: Similar to site 6, about 18 feet away on a hummock separated by trough from that of site 6; substrate moist, surface subject to drying; about 50 per cent cover of mosses and lichens, and a lesser cover of *Luzula, Poa,* and *Carex;* upper half of substrate, mostly peat with abundant roots and mixed with silt and sand; lower half of substrate, silt with scattered pebbles and very few roots.

Station III

Station III included a series of seven sites on an old beach ridge that lies about 500 feet behind and parallels the present western beach of the Arctic Ocean. The series began just above a small stream that paralleled the beach ridge, and continued up a gently sloping grade extending from the stream bank to the crest of the beach ridge. Along the slope, the coarse sands or gravels were somewhat mixed with silt, and had a thin cover of organic material.

Site 1: On coarse sand near stream edge but about 2 feet above water level; partial cover of mosses such as *Phippsia.*

Site 2: Upgrade from site 1; denser cover of mosses.

Site 3: Upgrade from site 2 and very similar to it except less cover of vegetation.

Site 4: Upgrade from site 3 and similar to it but with denser cover of mosses.

Site 5: At upper end of slightly graded gravel area extending from stream to base of beach ridge; vegetation mostly *Dupontia.*

Site 6: Lower slope of beach ridge; vegetation mostly *Salix* and *Potentilla.*

Site 7: Crest of beach ridge; vegetation an open cover mostly of *Elymus* with scattered lichens and *Potentilla;* substrate coarse sand.

Station IV

Station IV contained four sites grading from a swamp margin about 25 feet upslope to a slightly elevated hummock. The swamp had surface water only intermittently. The station area was located on the wet tundra about 75 feet behind the beach ridge of station III.

Site 1: At edge of swamp; peat substrate water-saturated; vegetation mostly *Eriophorum angustifolium.*

Site 2: Hummocky surface of *Sphagnum* in large part overgrown by a small leafy liverwort, *Lophozia.*

Site 3: Moss substrate over peat; scattered *Carex, Poa, Petasites,* and lichens.

Site 4: Top of low hummock; peat substrate; vegetation a mixture of *Petasites, Luzula, Poa,* lichens, and mosses; site well drained.

Station V

Station V consisted of a series of eight sites, and began on gravel flats in a swampy area, continued generally upslope over troughs and hummocks, then progressed downslope, ending on the bottom of a small, drained thaw-pond.

Site 1: On gravel flats in swampy area; substrate of banded peat, silt,

and sand; substrate water-saturated but not with surface water; vegetation of *Arctophila.*

Site 2: About 18 inches higher than site 1 and upslope toward ridge; soil better drained but always wet; vegetation mostly *Dupontia.*

Site 3: On top of hummock at edge of ridge; no vegetation on the site; soil a friable silt.

Site 4: On top of same hummock as site 3; silt mixed with some sand; little organic debris except at surface; vegetation of mosses, lichens, *Luzula,* and *Petasites.*

Site 5: Hummock top farther up ridge than site 4; dense cover of lichens, sedges, and grasses with occasional moss clumps.

Site 6: Trough on upslope side of hummock of site 5; wet soil; vegetation of grasses and sedges.

Site 7: Bottom of drained thaw-pond; wet soil; almost barren of vegetation but some *Eriophorum scheuchzeri* present.

Site 8: Same general area as site 7, but somewhat wetter; dense cover of *Dupontia, Carex,* and *Eriophorum.*

Station VI

Station VI had but a single site located on gravel flats. The substrate consisted mostly of coarse sand with bands of peat. The vegetation was essentially a pure stand of very dense, low-growing *Carex ursina.*

Miscellaneous Sites

In addition to samples from the sites described above, some samples were taken from miscellaneous habitats and were described only as "frost scar," "intermediate," or "marsh" Berlese samples. No other descriptive data were taken concerning these samples.

ANALYSIS OF COLLECTIONS

Tables 2 through 6 present qualitative and quantitative analyses of *Arctoseius* mites found in an early and a late summer sub-series of core samples from the six field stations and their included sites. Tables 7 through 12 show qualitative data from sub-series of samples from station II that supplement the information of table 2. The latter tables exemplify how the additional sub-series of samples of a particular station serve to make statements in the section on bionomics more certain. As indicated by these tables, not all of the samples were qualitatively analyzed for every species of *Arctoseius.* Qualitative data are not presented in tabular form for *Arctoseius robustus* because only four individuals were found among the samples of station II that were qualitatively studied. Information concerning this species was gained primarily from analysis of samples of stations IV and V, and of miscellaneous "intermediate Berlese" samples collected outside of the designated stations.

Supplementary qualitative data were obtained from sites of stations III through VI, but since fewer samples were studied, there is an insufficient amount of data to warrant its presentation in tabular form. Nevertheless, data from these qualitatively analyzed samples conform as closely to the

patterns of microhabitat distribution indicated in tables 3, 4, and 5 as those of station II conform to the patterns shown by table 2.

Table 13 is essentially a rearrangement and summary of the data in tables 2 through 6, emphasizing the known degrees to which the species of *Arctoseius* coexist in microhabitats represented by the various sites of the six field stations. *Arctoseius multidentatus, A. minor, A. robustus,* and *A. confusus* often were either absent or present in very low numbers of individuals among the samples of particular sites at which they are known to occur. Because of their absence in the two sub-series of samples selected for quantitative analysis, certain expected combinations of species at some of the sites were not actually observed. Nevertheless, these expected combinations very probably do occur, and analysis of larger numbers of samples for each site would probably verify such expectations. For a case in point, one need only compare the number of instances of coexistence shown by each of the two sub-series of samples in table 2. Therefore, in table 13 there is indicated in parentheses the number of sites at which coexistence would be expected to occur.

TABLE 2

ANALYSIS OF EARLY AND LATE SUMMER SUB-SERIES OF SAMPLES FROM FIELD STATION II*

Arctoseius species	June 29, 1953								August 18, 1953							
	Site								Site							
	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7
multidentatus ♂.....	0	0	1	0	1	0	0	0	–	0	1	0	0	0	0	0
♀.....	0	0	1	1	2	0	0	0	–	0	0	0	0	0	0	0
weberi ♂............	0	0	0	0	0	6	1	2	–	0	0	0	0	2	2	0
♀............	0	0	0	0	1	14	0	1	–	0	0	0	0	5	1	0
ornatus ♂...........	0	0	0	0	0	0	0	0	–	0	3	11	2	0	0	1
♀...........	0	3	7	7	1	0	0	0	–	0	15	9	9	0	0	1
minor ♂.............	0	0	0	0	0	1	0	1	–	0	0	0	0	0	0	2
♀.............	0	0	0	0	0	0	0	4	–	0	0	0	0	0	3	7
robustus ♂...........	0	0	0	0	0	0	0	0	–	0	0	0	0	0	0	0
♀...........	0	0	4	0	0	0	1	0	–	0	0	0	0	0	0	0
idiodactylus ♂.......	0	0	0	0	0	0	0	0	–	0	2	0	3	0	0	0
♀.......	0	1	9	3	0	0	0	0	–	0	7	0	1	0	0	0
confusus ♂..........	0	0	0	0	0	0	0	1	–	0	0	0	0	0	0	0
♀..........	0	0	0	0	0	0	0	1	–	0	0	0	0	0	1	1

* Numbers within tables 2 through 6 indicate the number of adult mites found in the Berlese sample of each site of the station. A dash (–) means that no sample was collected.

TABLE 3

ANALYSIS OF EARLY AND LATE SUMMER SUB-SERIES OF SAMPLES FROM FIELD STATION III

Arctoseius species	June 29, 1953							August 18, 1953						
	Site							Site						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
multidentatus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weberi ♂	0	0	0	0	0	1	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	2	0	0	0	0	0	0	0	0
ornatus ♂	0	0	0	0	0	0	0	1	0	0	0	0	0	0
♀	1	1	0	0	0	0	0	0	1	0	0	0	0	0
minor ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0
robustus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0
idiodactylus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	2
♀	0	0	0	0	4	3	0	0	0	0	0	0	9	3
confusus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 4

ANALYSIS OF EARLY AND LATE SUMMER SUB-SERIES OF SAMPLES FROM FIELD STATIONS IV AND VI

Arctoseius species	June 29, 1953				Aug. 17, 1953				June 29, 1953	Aug. 17, 1953
	Site				Site				Site	Site
	1	2	3	4	1	2	3	4	1	1
multidentatus ♂	0	2	2	0	0	2	0	0	0	0
♀	0	4	0	0	1	13	5	0	0	0
weberi ♂	0	0	3	0	0	2	0	0	0	0
♀	0	15	5	1	0	4	6	1	0	0
ornatus ♂	0	0	0	0	14	0	0	0	0	9
♀	16	0	0	0	24	0	0	0	28	43
minor ♂	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0
robustus ♂	0	0	0	0	0	0	0	0	0	0
♀	4	0	5	0	1	1	0	2	0	0
idiodactylus ♂	0	0	0	0	0	0	1	5	0	0
♀	0	0	4	6	0	0	0	2	3	0
confusus ♂	0	0	0	0	0	0	1	0	0	0
♀	0	0	1	0	0	0	0	3	0	0

TABLE 5

ANALYSIS OF EARLY AND LATE SUMMER SUB-SERIES OF SAMPLES FROM FIELD STATION V

Arctoseius species	June 29, 1953								August 17, 1953							
	Site								Site							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
multidentatus ♂	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	1	1	0	0	3	0	0	0	1	0	0
weberi ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ornatus ♂	0	0	0	0	0	0	0	0	0	10	0	0	0	3	2	8
♀	1	7	0	0	0	9	11	5	0	15	0	0	0	9	2	15
minor ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
robustus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
♀	0	1	0	0	0	3	0	0	0	1	0	0	0	0	4	0
idiodactylus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
♀	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	4
confusus ♂	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 6

ANALYSIS OF THE SINGLE SERIES OF SAMPLES FROM FIELD STATION I, JUNE 22, 1953

Arctoseius species	Site								
	1	2	3	4	5	6	7	8	9
multidentatus ♂	0	0	0	0	0	0	0	0	0
♀	1	0	0	0	0	0	0	1	0
weberi ♂	0	0	2	0	0	0	0	0	0
♀	0	0	14	0	0	4	10	0	0
ornatus ♂	0	0	0	0	0	0	0	0	0
♀	10	7	8	12	4	0	0	6	0
minor ♂	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	0	0
robustus ♂	0	0	0	0	0	0	0	0	0
♀	0	0	0	0	0	0	0	2	0
idiodactylus ♂	0	0	0	0	0	0	0	0	0
♀	25	5	9	11	0	0	0	0	0
confusus ♂	1	0	3	0	0	0	0	0	0
♀	6	0	2	0	0	0	0	0	0

TABLE 7

ANALYSIS OF SUB-SERIES OF SAMPLES OF STATION II FOR *A. multidentatus**

Date collected (1953)	Site							
	8	1	2	3	4	5	6	7
June 27	–	0	0	♀	♂♀	0	0	x
29	0	0	♂♀	♀	♂♀	0	0	0
July 3	–	x	0	♂♀	♂♀	x	0	0
6	–	0	♂	0	x	x	x	x
12	–	x	x	♀	x	0	0	x
15	–	0	x	x	♂♀	x	0	x
18	–	0	♀	♂♀	♂♀	0	0	0
21	0	0	♀	0	♂♀	0	0	x
24	x	0	x	♀	♀	0	0	0
27	x	x	0	0	x	x	0	x
August 5	–	0	x	x	0	x	0	x
8	–	x	x	x	x	0	0	0
11	–	x	x	x	♂	x	x	x
18	–	0	♂	0	0	0	0	0
25	–	x	x	0	0	0	0	x

* Symbols within tables 7 through 12 indicate the presence of neither (0), either (♂, ♀), or both (♂♀) sexes of the species of *Arctoseius* found in the samples of each site of the station that were studied. Samples not analyzed are indicated by (x), and a dash (–) means that no sample was collected. The sub-series of samples collected on June 29 and August 18 are the ones presented in table 2.

TABLE 8

ANALYSIS OF SUB-SERIES OF SAMPLES OF STATION II FOR *A. weberi*

Date collected (1953)	Site							
	8	1	2	3	4	5	6	7
June 27	–	0	0	0	0	♂♀	♀	x
29	0	0	0	0	♀	♂♀	♂	♂♀
July 3	–	x	0	0	0	x	♂♀	♂
12	–	x	x	0	x	♀	♂♀	x
18	–	0	0	0	0	♂♀	♀	♀
21	0	0	0	0	0	♂♀	x	x
24	x	0	x	0	0	♂♀	♂♀	♂♀
27	x	x	0	0	x	x	♂♀	x
30	x	x	x	x	x	♂♀	♂	x
August 8	–	x	x	x	x	♂♀	♀	♂♀
18	–	0	0	0	0	♂♀	♂♀	0
25	–	x	x	0	0	♂♀	♀	x

TABLE 9

ANALYSIS OF SUB-SERIES OF SAMPLES OF STATION II FOR *A. ornatus*

Date collected (1953)	Site							
	8	1	2	3	4	5	6	7
June 27	–	♀	♀	♀	♀	0	0	x
29	0	♀	♀	♀	♀	0	0	0
July 3	–	x	♀	♀	♀	x	0	0
6	–	♀	♀	♀	x	x	x	x
12	–	x	x	♀	x	0	0	x
18	–	♀	♀	♀	♀	0	0	0
21	0	♀	♀	♀	♀	0	0	x
24	x	♀	x	♀	♀	0	0	0
27	x	x	♀	♀	x	x	0	x
August 2	–	x	x	x	♂♀	x	x	x
5	–	0	x	x	♂♀	x	x	x
11	–	x	x	x	♂♀	x	x	x
18	–	0	♂♀	♂♀	♂♀	0	0	♂♀
25	–	x	x	♂♀	♂♀	0	0	x

TABLE 10

ANALYSIS OF SUB-SERIES OF SAMPLES OF STATION II FOR *A. minor*

Date collected (1953)	Site							
	8	1	2	3	4	5	6	7
June 27	–	0	0	0	0	♀	0	x
29	0	0	0	0	0	♂	0	♂♀
July 3	–	x	0	0	0	x	♀	♂♀
12	–	x	x	0	x	♀	♀	x
18	–	0	0	0	0	0	♀	x
21	0	0	0	0	0	x	♂♀	x
24	x	0	x	0	0	0	♀	0
27	x	x	0	0	x	x	♂	x
30	x	x	x	x	x	x	♀	x
August 8	–	x	x	x	x	♀	♀	♀
18	–	0	0	0	0	0	♀	♂♀
25	–	x	x	0	0	♂	♂♀	x

TABLE 11

ANALYSIS OF SUB-SERIES OF SAMPLES OF STATION II FOR *A. idiodactylus*

Date collected (1953)	Site							
	8	1	2	3	4	5	6	7
June 27	–	x	x	x	0	0	0	x
29	0	♀	♀	♀	0	0	0	0
July 12	–	x	x	♀	x	0	0	x
18	–	x	♀	♀	x	0	0	0
21	0	♀	x	♀	x	0	0	x
27	x	x	♀	x	x	x	0	x
August 5	–	x	x	♂♀	♀	x	x	x
8	–	x	x	♂♀	x	0	0	0
18	–	0	♂♀	♀	♂♀	0	0	0
25	–	x	x	♂♀	x	0	0	x

TABLE 12

ANALYSIS OF SUB-SERIES OF SAMPLES OF STATION II FOR *A. confusus*

Date collected (1953)	Site							
	8	1	2	3	4	5	6	7
June 29	0	0	0	0	0	0	0	♂♀
July 3	–	x	0	0	0	x	♀	0
12	–	x	x	0	x	0	0	0
18	–	0	0	0	0	0	0	x
21	0	0	0	0	0	0	x	0
24	x	0	x	0	0	♂	x	x
27	x	x	0	0	x	x	0	x
August 8	–	x	x	x	x	0	♀	0
18	–	0	0	0	0	0	♀	♀
25	–	x	x	0	x	x	♂♀	x

TABLE 13

COEXISTENCE OF THE SPECIES OF *Arctoseius* IN SAMPLES FROM ALL SITES OF SIX FIELD STATIONS*

Arctoseius species	Number of other species of known coexistents	Number of sites where the species of *Arctoseius* in left column coexists with other congeneric species — *Arctoseius* species: *multidentatus*	*weberi*	*ornatus*	*minor*	*robustus*	*idiodactylus*	*confusus*
multidentatus....	5	—	3(3)/10	9(9)/10	0(0)/10	5(9)/10	4(7)/10	2(2)/10
weberi...........	6	3(3)/11	—	2(3)/11	3(3)/11	5(5)/11	4(5)/11	6(6)/11
ornatus..........	6	9(9)/20	2(3)/20	—	1(1)/20	8(9)/20	12(12)/20	3(3)/20
minor...........	3	0(0)/3	3(3)/3	1(1)/3	—	0(2)/3	0(0)/3	2(3)/3
robustus.........	5	5(9)/14	5(5)/14	8(9)/14	0(2)/14	—	7(8)/14	2(4)/14
idiodactylus.....	5	4(7)/17	4(5)/17	12(12)/17	0(0)/17	7(8)/17	—	4(4)/17
confusus........	6	2(2)/7	6(6)/7	3(3)/7	2(3)/7	2(4)/7	4(4)/7	—

* Non-bracketed numbers of the numerator indicate the number of different sites where coexistence was observed. Bracketed numbers of the numerator indicate the total number of different sites where coexistence can be expected. The denominator indicates the number of different sites where the species of *Arctoseius* in the left column was collected.

BIONOMICS

Food habits of mites of the genus *Arctoseius* are not known. These mites are free-living inhabitants of the soil, generally associated with the Collembola and mite fauna found among the overlying dead and decaying layers of plant material. It has been supposed by various workers that these mites, like most other aceosejids, are predators of small arthropods. The occurrence of species of *Arctoseius* in the Berlese samples studied had no apparent association with the presence or absence of other kinds of mites present in these samples.

Although the number of individuals of each species of *Arctoseius* was often low in a single Berlese extraction, the over-all data acquired from all of the samples studied reveal some marked ecological and bionomical differences between the species. Reference to the data presented in tables 2 through 13 will make the following discussions more apparent.

Males of only four of the seven species of *Arctoseius* occurring at Barrow were present throughout the period of time during which Berlese samples were taken. In contrast, males of *Arctoseius ornatus*, *A. robustus*, and *A. idiodactylus* did not occur in the samples until late July or early August, after which time they were present in considerable numbers through the end of the period of sampling. This indicates that males of the last-mentioned

three species appear as a distinct generation at least a month later in the summer than do those of the other four species. Just how early in the season males of the other four species appear is, of course, impossible to determine from the Berlese collections used in this study.

It is probable that adult females of each species occur throughout the year in the Barrow area. Haarlov (1942) found females of *Arctoseius ?laterincisus* both in autumn and winter around Morkefjord on the east coast of Greenland, about 77° north latitude. Furthermore, oviposited overwintering eggs are not known to occur in the life cycle of aceosejid mites.

Table 13 indicates that each species of *Arctoseius* except *A. minor* coexists to at least some extent with five or six of the other species. As many as five of the seven species of *Arctoseius* have been observed to coexist in one sample. However, examination of many samples indicates that each species exhibits preferential differences in microhabitat occupancy.

Early- and late-season samples from the same sites revealed that there is no definite seasonal movement of the *Arctoseius* faunal components where they occur along topographical slopes. This would be expected in a tundra region of low topographic relief such as Barrow where high atmospheric humidity and well-saturated soils persist throughout the growing season.

Arctoseius ornatus and *A. idiodactylus* were found in some sites at every station, but they did not consistently occur with each other among the sites of stations III and IV. *Arctoseius ornatus* was the only species that regularly seemed to prefer those areas of lower relief that were not filled with water, such as the bottoms of drained thaw-ponds, margins around swamps and ponds, sand near river margins, gravel flats, and troughs between polygon mounds. The other six species were found, at least to some extent, on higher ground such as tops of hummocks and crests of various ridges. Although *Arctoseius idiodactylus* was found more often with *A. ornatus* than with any other species of *Arctoseius* (see table 13), *A. idiodactylus* also was found on the slope and crest of the beach ridge of station III and on a low hummock top of station IV.

Arctoseius weberi appeared to prefer drier areas of higher relief, such as hummocky surfaces and slopes rising out of moister bottom lands. This species was usually not found associated with *A. ornatus,* and was not collected at stations V and VI. *Arctoseius minor* was collected only at station II on the slopes and tops of peat hummocks. *Arctoseius multidentatus* was not found at stations III and VI. This species was found in coexistence with *A. ornatus* to a great extent in stations I, II, and V, but preferred a more hummocky surface in association with *A. weberi* in station IV.

Arctoseius confusus was not encountered in samples from stations III, V, and VI. This species preferred areas of high relief at stations II and IV but occurred in the bottom of the drained thaw-pond of station I. *Arctoseius confusus* was associated with *A. idiodactylus* at stations I and IV, but clearly not at II. *Arctoseius robustus* was not collected from stations III and VI, and was found in low numbers in areas of either high or low relief or both at the remaining stations.

Arctoseius ornatus, A. idiodactylus, and *A. weberi* were usually collected in greater numbers when they occurred in samples than were the other four

species. Denominator data in table 13 show that *A. ornatus* and *A. idiodactylus* were found in a larger number of different sites than the other species. No significance can be attributed to this, however, since not every site among the six field stations represented a type of microhabitat different from that of all other sites.

The following particular sites of stations were not suitable habitats for any of the species of *Arctoseius*. Site 8 of station II was submerged under water for most of the season. Sites 1 through 4 of station III were on an upgrade from a river bank towards the base of a beach ridge; the substrate was coarse sand with a partial cover of mosses. Station III as a whole yielded the poorest representation of individuals of *Arctoseius* species. Site 1 of station V was on water-saturated gravel flats in a swampy area. Sites 3, 4, and 5 of the same station were located on a hummock top which had silty soil and little overlying organic debris.

An understanding of the above microhabitat preferences of the various species of *Arctoseius* at Barrow cannot be achieved until research concerning the bionomics, especially the food habits, of these mites is conducted.

Hurd, Britton, and Pitelka (in manuscript) state that the high population levels of mites and Collembola near the end of the summer of 1952 were not present in the summer of 1953. During the 1952 season, the vegetation reached its most luxurious condition since the last lemming abundance in 1950. But during the winter of 1952–1953, the number of lemmings greatly increased. Being very polyphagous and voracious vegetarians, they cut or otherwise disturbed nearly all of the tundra vegetation between the frozen ground and overlying snow. As a result, the vegetation was so drastically altered by lemming activities that the high population levels of mites and Collembola of the summer of 1952 could not be maintained in the summer of 1953. Similar effects on the population levels of various insects, which either pass their developmental stages in association with tundra vegetation or are associated with this vegetation after emergence as adults, were observed.

SYMBIOSIS

In accordance with a report of the Committee on Terminology of the American Society of Parasitologists (Hertig *et al.*, 1937) and with Steinhaus (1949), the term "symbiosis" is used with a broad denotation in this paper. Thus, "symbiosis" refers to interrelations or associations between species living together in close spatial relationship, without any implication of, or distinction between, benefit or detriment to either of the species involved. The term "parasitism," then, is used herein with reference to those antagonistic symbiotic interrelationships between species in which one member, the parasitic symbiote, derives benefit at the expense of the other member, the host symbiote.

Individuals of three different species of *Arctoseius* from Barrow have been observed to contain enormous numbers of minute spores in the lumina of the idiosoma, gnathosoma, and legs. Very little information concerning this internal symbiote exists. In fact, on the basis of the spore structure alone, the microorganism at present cannot be identified positively as belonging either to the plant or to the animal kingdom. The only form of the symbiote

that was observed is apparently a resting spore stage. The spores are spherical, about 14 microns in diameter, and have a thick external wall consisting of two distinct layers. The internal contents of the spore appear to be finely granular cytoplasm. Some of the spores contain a relatively transparent region that is more likely a vacuolar rather than a nuclear structure. These spores were observed in adult females of *Arctoseius weberi, A. ornatus,* and *A. robustus,* and in an adult male of *A. weberi.* Among the hundreds of specimens of *Arctoseius* that were examined from Barrow, fewer than fifteen contained these spores. The symbiotes observed in the above three species of mites appeared to be morphologically identical, and it is likely that only one species was involved. Probably, this species can occur within any of the species of *Arctoseius* found at Barrow.

Sig Thor (1930) was the first worker to record this kind of symbiote within mites. He classified them as parasites of the group Haplosporidia in the class Sporozoa. From the Spitsbergen Islands alone, Thor found that mites of a variety of species were hosts of the Haplosporidia. He recorded the following list of hosts: Mesostigmata: *Arctoseius laterincisus* Thor, *Zercon triangularis* Koch, *Vitzthumia oudemansi* Thor; Prostigmata: *Rhagidia gelida* Thorell, *Molgus capillatus* (Kramer), and *Cyta latirostris* (Hermann); Oribatei: *Hermannia reticulata* Thorell, *Ameronothrus lineatus* (Thorell), *Diapterobates notatus* (Thorell). Thor named the parasites with reference to the name of their respective hosts. He proposed a new genus and new species for the parasite of each different host genus and species, although he admitted that, on the basis of the spore stage alone, such a classification would necessarily be hypothetical and uncertain.

The parasite *Arctosporidium lucidum* Thor, which was found in living specimens of *Arctoseius laterincisus,* is probably the symbiote of the Barrow species of *Arctoseius.* It is possible that the host range of this microorganism may not be restricted to species of the genus *Arctoseius.*

The Haplosporidia, class Sporozoa, are presently recognized as belonging to the phylum Protozoa, although the group has often been confused with lower fungi of the class Phycomycetes. In fact, the Haplosporidia were referred to as "niedere Pilze" by Reichenow, who assisted Thor in the identification of the acarine parasites. Even at present, however, there remains the possibility that these symbiotes of *Arctoseius* are a fungus rather than a haplosporidian. Fungi of the order Entomophthorales, class Phycomycetes, are known to produce resting spores, either zygospores or parthenogenetic azygospores, in great numbers within the body cavity of their arthropod hosts, primarily insects. The size, shape, and structure of some of these spores are very similar to those found within *Arctoseius* mites.

Although it is not known whether the spores in question have a definite parasitic association with their acarine hosts, such an association appears to be the most probable one, since members of both the Haplosporidia and Entomophthorales are known to be parasitic. Positive identification and classification of these spore-formers must await the task of collecting and maintaining the acarine hosts alive under laboratory conditions, so that the spores may be observed to develop into other active stages of their life cycle.

An entirely different type of symbiote also occurs in association with living *Arctoseius* mites at Barrow. It was observed that two females of *A. idiodactylus* from station I, site 3, and one female of *A. minor* from station II, site 6, each had one or two elongate microorganisms on the integument of the body dorsum. Dr. E. A. Steinhaus of the University of California at Berkeley has identified the symbiote as an entomogenous fungus of the order Laboulbeniales, class Ascomycetes.

It is difficult to distinguish between a commensal and a parasitic association when the apparently borderline cases involving laboulbeniaceous fungi and their arthropod hosts are considered. The fungi may be considered to have an obligate commensal association with their arthropod hosts, growing and multiplying almost entirely on the external surfaces of the host and apparently causing little or no inconvenience to it in most cases. They also may be considered as cutaneous parasites if, in gaining nourishment from the host, the fungi exert a harmful effect, however slight, on the host. The association of the Laboulbeniales with their hosts is an obligate one, since, according to Steinhaus (1949), the life of the fungus is dependent upon the continued life of the host. The fact that only three out of hundreds of specimens of *Arctoseius* bore these symbiotes appears to indicate a low level of infestation among the mites at Barrow, at least during the summer of 1953.

Steinhaus (1949) stated that the site of attachment of the fungus on insects is usually limited to definite regions on the integument of each host species. This may be true to some extent in the case of the *Arctoseius* symbiote, but a conclusion cannot be based on so few individuals. One host specimen of *A. idiodactylus* had one fungus located on the membranous integument between setae L4 and S3, and another on the membrane between setae L3 and S1 on the opposite side of the body. On the second host specimen of this species, two fungi were again on opposite sides of the body but were attached to the dorsal shield, one between setae M8 and S7, the other mesially beside seta M7. The specimen of *A. minor* bore only one symbiote, located ventrolaterally on the membranous cuticle above seta S10. The author observed a female of *A. cetratus* (Sellnick) collected in Berkeley, California, to have one of these laboulbeniaceous fungi on the lateral membrane beside seta S4. The body, exclusive of the foot, of these symbiotes is elongate-oval in shape; the size varies, the length from about 50 to 75 microns, and the greatest width from 9 to 16 microns.

Thaxter (1896, 1924, 1926), in his exhaustive monograph of the Laboulbeniaceae, described eighteen species of *Rickia*, five species of *Dimeromyces*, two species of *Dimorphomyces*, and one of *Laboulbenia* as symbiotes of mites representing twenty different genera. The host genera represent the following cohorts of Acarina: Gamasina, Uropodina, and Antennophorina of the Mesostigmata; and Acaridia and Aptyctima of the Sarcoptiformes. An additional record of another genus of the fungus on an acarine host is provided by Colla (1934), who recorded *Eugamasus sp.* as the host of *Rhynchophoromyces rostratus* Thaxter. Steinhaus (1949) notes that each species of fungus is apparently restricted to a certain genus of insects, and Thaxter's work seems to verify this generality with respect to mites also.

SYSTEMATICS

The genus *Arctoseius* Thor has been well defined in the studies of Willmann (1949) and Evans (1955, 1958). Only the more important diagnostic characters of the genus are presented here.

The dorsal shield of deutonymphs and adults has a pair of lateral incisions about midway on the idiosoma. The dorsal shield bears thirty-one to thirty-four pairs of simple setae, fourteen pairs of which are situated posterior to the lateral incisions. On females, the lateral membranous cuticle of the idiosoma bears nine or ten pairs of setae. On males, the anterolateral margins of the dorsal shield often fuse more extensively with the peritrematal plates than on females, leaving six to nine pairs of setae on the lateral membrane.

The epigynial shield of the female is narrow, convexly curved along the posterior margin, and without setae and pores; it is usually well separated from an anal shield or, rarely, a ventrianal shield. The genital setae and pores are situated on the membranous cuticle lateral to the epigynial shield. The sternal shield usually bears the three pairs of sternal setae, but the first pair are on jugularia in some species. The metasternal setae are usually situated on the membranous cuticle. The anal shield is usually small and subcircular, and normally bears only the two para-anal and the postanal setae. However, *Arctoseius magnanalis* Evans is an exception in that the increased sclerotization of the anal region includes one pair of ventral setae in addition to the anal setae and thus forms a ventrianal shield.

On males, the sternogenital shield bears the metasternal setae in addition to the sternal setae, and may or may not bear the genital setae; the shield is distinct from, but close or contiguous to, a ventrianal or, rarely, a ventral shield. The idiosoma of males is usually narrower than that of females so that the dorsal shield covers the idiosoma more completely. In both sexes, all legs bear a lobed pulvillus and two claws. The tectum is bi- or tridentate. The fixed chela bears a short pilus dentilis.

Haarlov (1942) figured and redescribed what he considered to be the type species, *Arctoseius laterincisus* Thor, from specimens of *Arctoseius* collected by him in Greenland. Evans (1955) stated that it is impossible to be certain that the type material of Thor from Spitsbergen and the material of Haarlov from Greenland are conspecific without first examining Thor's original type material. Nevertheless, Evans (1955), like Willmann (1949), accepted Haarlov's concept of Thor's species, and Evans used as a diagnostic character of that species a questionable sensory organ that Haarlov found on only the left tarsus of leg I on one of his two specimens.

Until the original type material of Thor's species is carefully re-examined, one is inclined to believe, on the basis of the following morphological comparisons, that Haarlov's descriptions and figures concern a species of *Arctoseius* other than *A. laterincisus* Thor. First, the photographs of Thor's specimens, both male and female, clearly show that the posteriormost pair of mediolateral setae on the dorsal shield and the posteriormost pair of ventral setae on the body venter are relatively long, whereas these setae were described and figured as short on Haarlov's specimens. Chaetotaxic differences such as those between Thor's and Haarlov's specimens have not

been observed to occur as infraspecific variation within any of the presently described species of *Arctoseius.*

Second, *A. laterincisus* Thor is a relatively large species when compared to other species of the genus. Thor gave the idiosomal dimensions of his female specimens as 750–800μ long and 380–400μ broad. Females of most of the heretofore described species have idiosomal lengths of less than 500μ. Haarlov neglected to give idiosomal dimensions of his specimens of *Arctoseius,* but he did provide a linear scale of reference with each figure. From his figure and linear scale of the venter of his specimens, it can be estimated that the idiosoma has dimensions of 420μ in length and 240μ in width. None of the species of *Arctoseius* described to date are known to vary in size to an extent that would approach a range including the differences in size between Thor's and Haarlov's specimens.

Third, although the shape of the epigynial shield varies considerably among individuals of the same species, the shape of this shield is nevertheless somewhat distinctive in the cases of some species of *Arctoseius.* Like the condition found in most species of *Arctoseius,* the epigynial shield of Haarlov's specimens is narrowly bulb-shaped with gently concave lateral margins. In contrast, the epigynial shield of *A. laterincisus* as photographed in Thor's work is broad and somewhat wedge-shaped due to the almost straight lateral margins of the shield.

Finally, it is noteworthy that relatively short peritremes are characteristic of several species of *Arctoseius.* In both *A. multidentatus* Evans and *A. cetratus* (Sellnick) the peritremes extend anteriad only to the mid-level of coxae II. The peritremes of Haarlov's specimens are figured as reaching only to the mid-level of coxae III. Although one cannot be certain, it appears from the photograph of the body venter of a female of Thor's species that the peritremes extend as far anteriad as the level of the anterior margin of coxae III.

Evans (1955) described as new species and figured in detail the females of *Arctoseius ornatus, A. weberi,* and *A. multidentatus* from material collected by Weber in 1950 from Point Barrow, Alaska. For each of these species Evans had only one or two specimens, none of which were males. The males remained unknown until the author found specimens in Berlese samples collected by Hurd in 1952–1953 from Barrow. In addition, a number of males in the Hurd collections were found which indicated that four more species of *Arctoseius,* all new to science, are represented at Barrow. Females of each species were far more numerous in the collections, but they are more difficult to identify specifically than are the males.

Males of the other heretofore described species of *Arctoseius* apparently occur in far less numbers than the corresponding females during most of the year. It is significant to note that, of the eighteen original or synonymic descriptions of the heretofore known species of *Arctoseius,* fourteen are based on females only. Descriptions of males are of definite value in more clearly delimiting each species morphologically and in contributing to the over-all generic concept of the included species. The present study shows that the sclerotization of the body venter of males of various species is not as constant in form as was presumed earlier. Males of the Barrow species

demonstrate even more clearly that the spermatophoral process usually has a unique shape that is of great diagnostic value for each species. It should be emphasized that, in describing and illustrating the spermatophoral process, the lateral aspect of the process should be complemented by the dorsoventral aspect in order to effect a three-dimensional concept of the structure (see plate XIX).

In the following descriptions, the system of nomenclature adopted for the chaetotaxy of the dorsal shield is based primarily on the system used by Athias-Henriot (1957, 1958) for genera of the families Aceosejidae and Phytoseiidae. The setae of the body dorsum are grouped into four longitudinal rows including a dorsocentral (D), mediolateral (M), and lateral (L) series which are situated on the dorsal shield, and a sublateral (S) series which is situated either along the lateral margin of the shield or on the lateral membranous cuticle of the idiosoma. Using this system of chaetotaxy, characteristics of the genus *Arctoseius* are complete series of dorsocentral and mediolateral setae, the absence of L7 from the lateral series, and the absence of S5 from the sublateral series (see plate II). In some species of *Arctoseius* the second lateral setae, L2, are situated on the lateral membrane. In this position, setae L2 superficially appear to be members of the sublateral series of setae which in turn appears to consist of ten pairs of setae rather than the actual number of nine pairs. Males of some of the species described in this paper lack setae S8 and S9, and often have S1 and S2, and, more rarely, S3, on the lateral margin of the dorsal shield; in such cases, only four or five pairs of sublateral setae occur on the lateral membrane.

The length of the corniculus was determined on the basis of the entire cornicular structure, including the basal portion which is imbedded to a greater or lesser extent in the anterolateral extremity of the rostrum, but which is readily visible in cleared specimens mounted on microslides. A less variable measurement of the corniculus is obtained from a series of individuals of one species when the entire cornicular length is used for measurement. It is noteworthy that the length ratio of the entire corniculus to the movable chela will be markedly higher than the ratio obtained when only that portion of the corniculus projecting free from the rostrum is used as the length of the corniculus. This difference in method of measuring the comparative lengths of corniculi explains the apparent discrepancy between the corniculus-movable chela length ratios in this paper and those in Evans' paper (1955).

The following characteristics, though not shared by all described species of *Arctoseius* and therefore not always generically diagnostic, are common to all of the seven species presently recognized from Barrow, Alaska. The peritrematal plates extend posteriorly a short distance around the posterior margins of coxae IV. The exopodal plates are fragmental, free from the peritrematal plate, and situated ventrolaterally between coxae II and III, and between coxae III and IV. A pair of free endopodal plates occur as narrow sclerotized strips along the anteromedian margins of coxae II; they are nearly contiguous with the anterolateral projections of the sternal shield. The tectum is tridentate. The venter of the gnathosoma bears four pairs of simple setae, of which the anterior rostral and internal posterior rostral

pairs are long and the external posterior rostral and capitular pairs are much shorter. The distal extremity of leg I bears several rod-like sensory setae, none conspicuously enlarged, and a slender tactile seta that is clavate distally.

On females, the following additional characters are common to the seven Barrow species. Free endopodal plates occur in the region of coxae III–IV as a pair of narrow sclerotized strips. The sternal shield bears the three pairs of sternal setae and their associated pores. The metasternal setae are situated freely on membranous cuticle behind the sternal shield. The metapodal plates are elongate in form. The anal shield bears only the para-anal and postanal setae.

The diagnostic characters given below for females of the species described by Evans are based on the original descriptions and figures of Evans and on additional specimens collected near the type locality, Point Barrow, Alaska.

Original descriptions in this paper are based on a single specimen, the holotype, allotype, or neallotype.[1] Infraspecific variation displayed by other specimens is indicated parenthetically within the original description of each species. Teratological variations of various specimens are described apart from the original descriptions, at the end of the discussion of each species.

Key to Species of *Arctoseius* at Barrow, Alaska

1. Para-anal setae subequally as long as postanal seta; corniculus long, subequally as long as movable chela; peritremes very short, reaching anteriad only as far as middle of coxae II; ventrianal shield of male narrow, not covering metapodal plates. *multidentatus*
—Para-anal setae not more than half as long as postanal seta; corniculus shorter, not more than two-thirds as long as movable chela; peritremes reaching at least as far anteriad as posterior margins of coxae I; ventral or ventrianal shield of male variable in extent...2
2. Pre-endopodal plates strongly sclerotized; peritremes reaching only as far as posterior margins of coxae I; males with ventral shield well separated from anal shield....*weberi*
—Pre-endopodal plates weakly sclerotized or absent; peritremes longer, extending onto dorsolateral surface of idiosoma above coxae I; males with ventrianal shield.........3
3. Peritremes very long, extending anteriad to level of setae M1 of dorsal shield; setae D9 and D10 at least four-fifths as long as D3..................................*ornatus*
—Peritremes long, but extending no farther anteriad than to level varying from seta L1 to three-fourths of distance from L1 to M1 of dorsal shield; setae D9 and D10 one-half to four-fifths as long as D3...4
4. Setae D9 and D10 two-thirds to four-fifths as long as D3; females with lateral margins of anal shield rounded; males with spermatophoral process simple in form, with neither abrupt change in thickness nor undulate curvature..............................5
—Setae D9 and D10 one-half to two-thirds as long as D3; females with lateral margins of anal shield usually flattened; spermatophoral process of males either simple or with abrupt change in thickness and with undulate curvature 6
5. Sternal or sternogenital shield ornamented only along lateral margins; anal shield of female usually broadly ovate, about as wide as long, the rounded contour of its lateral margins distorted by a pair of protruding lateral pores; ventrianal shield of male not sufficiently wide to cover metapodal plates; small mites, length of idiosoma: females 380–440μ, males 335–360μ...................................*minor*

[1] The term "neallotype" has been used in the past and is used in this paper to designate a specimen of opposite sex to the holotype, chosen later, either by the original author or by any subsequent student, and not necessarily from the original type series. The neallotype, then, is the specimen that is used as the physical basis for the first description of the sex opposite that of the holotype, whenever this description is published subsequent to the description of the holotype.

—Sternal or sternogenital shield ornamented over entire surface; anal shield of female elliptical, wider than long, the rounded contour of its lateral margins not distorted by the pair of lateral pores; ventrianal shield of male wide, overrunning areas occupied by metapodal plates; moderately sized mites, length of idiosoma: females 470–530μ, males 405–470μ . . . . *confusus*

6. Sternal or sternogenital shield ornamented over entire surface, more faintly in middle; anal shield of female wider than long, its anterior and lateral margins usually smoothly flattened, giving shield a subquadrate shape; spermatophoral process of males simple in form, with neither abrupt change in thickness nor undulate curvature; large mites, length of idiosoma: females 585–740μ, males 475–545μ. . . . . *robustus*

—Sternal or sternogenital shield ornamented only along lateral margins; anal shield of female usually as long or longer than wide, its lateral margins flattened but usually not giving shield a subquadrate shape; basal half of spermatophoral process of males conspicuously expanded laterally and ventrally, its lateral surface flattened; process abruptly constricted about midway along length, leaving distal half very slender with undulate curvature; moderately sized mites, length of idiosoma: females 420–525μ, males 370–405μ . . . . *idiodactylus*

1. *Arctoseius multidentatus* Evans

(Plates I; II; XIX, figs. 11, 12; XXI, figs. 1, 2; XXII, fig. 4)

Arctoseius multidentatus Evans, 1955, Bul. Brit. Mus. (Nat. Hist.) Zool. 2(9):291–294, figs. ♀; Evans, 1958, Proc. Zool. Soc. Lond. 131(2):223.

Both sexes of *Arctoseius multidentatus* may be distinguished by the long para-anal setae, by the long corniculi, and by the very short peritremes. The shape of the spermatophoral process and the shape of the ventrianal shield of the male, and the shape and lack of ornamentation of the anal shield of the female, are also distinctive for this species.

Male. Dorsal shield lightly ornamented. Sublateral series with nine pairs of setae, all on lateral membrane. Seta L2 consistently on margin of dorsal shield. Setae of idiosomal dorsum relatively long; setae D9 and D10 about two-thirds as long as D3. Peritrematal plates fused anteriorly with dorsal shield. Peritremes short, extending anteriad only as far as middle of coxae II. Pre-endopodal plates absent, but traces of sclerotization of integument anterior to sternogenital shield present. Sternogenital shield ornamented only along lateral margins between first sternal and metasternal pairs of setae; shield constricted at level of coxae IV but genital setae on its postero-lateral margins. Endopodal plates fused to sternogenital shield at level between third sternal and metasternal setae (these plates entirely free from sternogenital shield on some specimens). Ventrianal shield well ornamented, irregular in outline and relatively narrow, with five of the eight (seven on some specimens) pairs of ventral setae in addition to the anal setae. Ventrianal shield extending laterad only as far as longitudinal mid-levels (but on one specimen to external margins) of coxal cavities IV, thus not approaching the free metapodal plates. Para-anal setae at least three-fourths as long as postanal seta.

Corniculi long, subequally as long as movable chelae. Movable chela unidentate; fixed chela multidentate along entire inner margin, with pilus dentilis. Spermatophoral process curving dorsomedially just anterior to tip of movable chela, then apically becoming more slender and recurving ventro-laterally. Posteroventral surface of femur II near distal extremity with

stout spine-like seta on elevated base; most proximal ventral seta on tarsus II very stout, on elevated base. Only the two ventral subapical setae of tarsi II–IV short, spine-like; two dorsal subapical setae slender, about twice as long as ventral subapical setae. Dorsal shield dimensions: neallotype, length 526μ, width 267μ (range among ten other specimens: length 502–550μ, width 222–280μ).

Female. Ornamentation and chaetotaxy of dorsal shield like those of male except seta L2 either on shield or on lateral membrane. Peritrematal plates fused anteriorly with dorsal shield; peritremes like those of male. Pre-endopodal plates absent and presternal sclerotization absent or indistinct; anterior margin of sternal shield distinct, extending between first pair of sternal setae. Sternal shield ornamented along lateral margins, often less distinctly in center, sometimes on distinctly outlined posteromedian area between second and third pairs of sternal setae. Epigynial shield somewhat wedge-shaped, its lateral margins straight or very slightly concave. Membranous cuticle posterior to epigynial shield with eight pairs of ventral setae. Anal shield unornamented, unevenly elliptical, and longer than wide; lateral margins of anal shield hardly or not at all distorted by lateral pores. Para-anal setae subequally, or at least three-fourths, as long as postanal seta.

Movable chela bidentate; fixed chela like that of male. Other gnathosomal structures like those of male. Distal seta on posteroventral surface of femur II and proximal seta on ventral surface of tarsus II slender, not spine-like. Subapical setae of tarsi II–IV like those of male. Range of dorsal shield dimensions among six specimens: length 609–677μ, width 280–341μ. Idiosomal dimensions of holotype given by Evans, length 605μ, width 275μ.

Neallotype. Male, Barrow, Alaska, August 11, 1953 (P. D. Hurd, Jr.), from station II, site 4; deposited in U. S. National Museum.

Plesiotypes. Barrow, Alaska (P. D. Hurd, Jr.); males collected from June 24, females from June 22, through August 25, 1953; specimens collected from station I, sites 1 and 8, station II, sites 2, 3, and 4, station IV, sites 1, 2, and 3, station V, sites 2, 6, and 7.

2. *Arctoseius weberi* Evans

(Plates III; IV; XIX, figs. 13, 14; XX, fig. 2; XXI, fig. 4; XXII, figs. 1, 2)

Arctoseius weberi Evans, 1955, Bul. Brit. Mus. (Nat. Hist.) Zool. 2(9):291–292, figs. ♀; Evans, 1958, Proc. Zool. Soc. Lond. 131(2):223.

Both sexes of *Arctoseius weberi* are recognized by the distinct pre-endopodal plates and by the reduced peritremes. The male of this species, in addition to having a spermatophoral process of very unique form, is the only representative of the genus known at present to possess a ventral shield separate from the anal shield.

Male. Dorsal shield lightly ornamented. Seta L2 consistently on margin of dorsal shield. Nine pairs of sublateral setae on lateral membranous cuticle. Setae of idiosomal dorsum of moderate length; setae D9 and D10 about three-fourths as long as D8. Peritrematal plates narrowly united (not united on some specimens) anteriorly to dorsal shield. Peritremes reduced, extending anteriad only as far as posterior margins of coxae I. Pre-endopodal plates

distinct, well sclerotized, and separated from the definite anterior margin of sternogenital shield at level of first pair of sternal setae. Sternogenital shield lightly ornamented over entire surface, more heavily along lateral margins between first sternal and metasternal setae; shield narrowed at level of coxae IV but with genital setae on its posterolateral margins. Endopodal plates weakly fused to sternogenital shield between third sternal and metasternal setae (these plates free from shield on some specimens). Ventral shield well ornamented, gently concave along posterior margin, with four of the seven pairs of ventral setae, and well separated from anal plate. (One or two setae usually on ventral shield excluded from shield on some specimens due to irregular margin of shield.) Ventral shield extending laterad only as far as external margins of coxal cavities IV, thus leaving metapodal plates free. Anal plate like that of female, ornamented, evenly rounded, about as broad as long, with only the three anal setae. Para-anal setae about half as long as postanal seta.

Corniculi two-thirds as long as movable chelae. Movable chela unidentate; fixed chela with six (seven to nine on many specimens) teeth and pilus dentilis. Spermatophoral process constricting immediately beyond tip of movable chela, then abruptly re-expanding dorsoventrally into shape of asymmetrical spoon. Posteroventral surface of femur II near distal extremity with stout spine-like seta on elevated base; most proximal ventral seta on tarsus II shortened, stouter than that of female. Only the two ventral subapical setae of tarsi II–IV short, spine-like; two dorsal subapical setae slender, about twice as long as ventral subapical setae. Dorsal shield dimensions: neallotype, length 429μ, width 246μ (range among fifteen other specimens, length 428–466μ, width 236–259μ).

Female. Ornamentation and chaetotaxy of dorsal shield as in male except seta L2 either on shield or on lateral membrane. Peritrematal plates not fused anteriorly with dorsal shield; peritremes like those of male. Pre-endopodal plates distinct as in males; anterior margin of sternal shield extending between first pair of sternal setae. Entire surface of sternal shield ornamented. Membranous cuticle posterior to epigynial shield with eight pairs of ventral setae. Anal shield ornamented, evenly rounded, about as broad as long; lateral margins of anal shield slightly or not at all distorted by lateral pores. Para-anal setae about one-half as long as postanal seta.

Movable chela bidentate; fixed chela as in male. Other gnathosomal structures like those of male. Distal seta on posteroventral surface of femur II and proximal seta on ventral surface of tarsus II slender, not spine-like. Subapical setae of tarsi II–IV like those of male. Range of dorsal shield dimensions among sixteen specimens: length 508–561μ, width 275–307μ. Idiosomal dimensions of holotype given by Evans: length 540μ, width 286μ.

Neallotype. Male, Barrow, Alaska, June 29, 1953 (P. D. Hurd, Jr.), from station II, site 5; deposited in U. S. National Museum.

Plesiotypes. Barrow, Alaska (P. D. Hurd, Jr.); males and females collected from June 22 through August 25, 1953; specimens collected from station I, sites 3, 6, and 7, station II, sites 4, 5, 6, and 7, station III, site 6, station IV, sites 2, 3, and 4.

3. *Arctoseius ornatus* Evans

(Plates V; VI; XIX, figs. 1, 2; XXII, fig. 3)

Arctoseius ornatus Evans, 1955, Bul. Brit. Mus. (Nat. Hist.) Zool. 2(9): 289–291, figs. ♀; Evans, 1958, Proc. Zool. Soc. Lond. 131(2):223.

Both sexes of *Arctoseius ornatus* may be distinguished from the other species of *Arctoseius* that occur at Barrow by the very long peritremes, by the D9/D3 setal length ratio, and usually by the definite anterior margin of the sternal or sternogenital shield that extends between the anteriormost pair of sternal setae.

Male. Dorsal shield strongly ornamented. Setae L2, S1, and S2 on margin of dorsal shield (variation from only L2 to L2 plus the first three pairs of sublaterals on dorsal shield of other specimens); remaining setae of sublateral series on lateral membrane; only seven pairs of sublateral setae present, S8 and S9 being absent. Setae of idiosomal dorsum moderately long; setae D9 and D10 at least four-fifths as long as D3. Peritrematal plates well united anteriorly to dorsal shield. Peritremes very long, extending anteriad beyond coxae I to setae M1 (or at least seven-eighths of distance from setae L1 to M1 on some specimens) on dorsal body surface. Pre-endopodal plates absent but traces of sclerotization present anterior to sternogenital shield; anterior margin of sternogenital shield extending between first pair of sternal setae. Sternogenital shield ornamented over entire surface but indistinctly in middle and on genital area; shield narrowed at level of coxae IV but genital setae on its posterolateral margins (genital setae on membranous cuticle on either side of shield on some specimens). Endopodal plates fused to sternogenital shield between genital and metasternal setae. Ventrianal shield broad, strongly ornamented, with six of the seven pairs of ventral setae in addition to the anal setae. Ventrianal shield extending laterad beyond external margins of coxal cavities IV, thus covering areas occupied by metapodal plates. Position and outline of metapodals still evident through ventrianal shield. Para-anal setae about half as long as postanal seta.

Corniculi two-thirds as long as movable chelae. Movable chela unidentate; fixed chela with five (four to six on other specimens) teeth and with pilus dentilis on small dentiform elevation. Spermatophoral process slender, tapering, extending anteriad beyond tip of movable chela, and curving evenly dorsad. Femur and tarsus of leg II without setae markedly differentiated from those of female. All four subapical setae of tarsi II–IV short, spine-like. Dorsal shield dimensions: neallotype, length 418μ, width 222μ (range among seventeen other specimens: length 397–444μ, width 201–238μ).

Female. Second pair of lateral setae either on margin of dorsal shield or on lateral membrane. All nine pairs of sublateral setae on lateral membrane. Ornamentation and remaining chaetotaxic features of dorsal shield like those of male. Peritrematal plates usually fused anteriorly with dorsal shield; peritremes like those of male. Pre-endopodal plates absent or weakly sclerotized; anterior margin of sternal shield uneven, concave, extending between first pair of sternal setae and not masked by presternal areas of sclerotization. Sternal shield ornamented over entire surface although more faintly

in middle. Membranous cuticle posterior to epigynial shield with nine or occasionally eight pairs of ventral setae. Anal shield ornamented, evenly rounded, nearly circular in contour; lateral margins of anal shield not distorted by lateral pores. Para-anal setae slightly less than half as long as postanal seta.

Movable chela bidentate; fixed chela and other gnathosomal structures as in male. Range of dorsal shield dimensions among twenty-one specimens: length 503–555μ, width 270–312μ. Idiosomal dimensions of holotype and paratype given by Evans: length 490–528μ, width 280–285μ.

Neallotype. Male, Barrow, Alaska, August 13, 1953 (P. D. Hurd, Jr.), from a miscellaneous "intermediate Berlese" sample; deposited in U. S. National Museum.

Plesiotypes. Barrow, Alaska (P. D. Hurd, Jr.); males collected from July 26 through August 25, 1953, and females collected from June 22 through August 25, 1953; specimens collected from station I, sites 1, 2, 3, 4, 5, and 8, station II, sites 1, 2, 3, 4, and 7, station III, sites 1 and 2, station IV, site 1, station V, sites 1, 2, 6, 7, and 8, station VI.

The spermatophoral process of *A. ornatus* appears to be very similar in form to those of *Arctoseius butleri* (Hughes) and *Arctoseius magnanalis* Evans as illustrated by their respective authors.

The many male and female specimens of *A. ornatus* that were examined differ from the figures of Evans so far as relative setal lengths of the dorsum of the idiosoma and the venter of the gnathosoma are concerned. Therefore, these features are reillustrated in this paper. Also, Evans shows only eight pairs of ventral setae in his figure of the holotype. A ninth pair should be located where Evans has drawn a "pore"—really the base of a seta—lateral to the anterior margin of the anal shield. A few females were seen that lack this ninth pair of ventral setae, but they also lack any evidence of pores in the area that would normally be occupied by these setae.

4. *Arctoseius minor,* new species

(Plates VII; VIII; IX; XIX, figs. 3, 4; XXI, fig. 3)

Small size, the relatively short setae of the dorsal shield, the long peritremes, and the confluence of the sternal or sternogenital shield with presternal areas of sclerotization are characteristics that help in the identification of both sexes of *Arctoseius minor*. The shape of the spermatophoral process and the unusual shape of the ventrianal shield specifically identify the male. The shape of the anal plate is the most distinctive single character of the female.

Male. Dorsal shield strongly ornamented. Seta L2 on lateral membrane (or on lateral margin of dorsal shield on some specimens); setae S8 and S9 absent; remaining seven pairs of sublateral setae on lateral membrane. Setae of idiosomal dorsum relatively short; setae D9 and D10 about three-fourths as long as D3. Peritrematal plates united anteriorly to dorsal shield. Peritremes long, extending onto regions above coxae I to a level one-half (level varying from one-half to three-fourths on other specimens) of distance from setae L1 to M1 of body dorsum. Pre-endopodal plates absent; sternogenital shield united anteriorly with presternal areas of sclerotization surrounding the

genital orifice; shield without distinct anterior margin between first sternal setae but with margin distinct laterad of these setae. Sternogenital shield ornamented only along lateral margins from first sternal to just behind metasternal pairs of setae, and lightly ornamented on genital region; shield narrowing posteriorly at level of coxae IV so that genital setae on membranous cuticle beside shield. Endopodal plates united to sternogenital shield between fourth sternal and genital setae. Ventrianal shield ornamented, irregular in outline (variable in width on different specimens), not extending laterad beyond outer margins of coxal cavities IV, thus leaving metapodal plates free. Ventrianal shield with six of the seven pairs of ventral setae in addition to the anal setae. Para-anal setae about half as long as postanal seta.

Corniculi about two-thirds as long as movable chelae. Movable chela unidentate; fixed chela quadridentate, with pilus dentilis on small elevation. Spermatophoral process extending anteriad beyond tip of movable chela, tapering and curving slightly dorsally. Leg II without setae differentiated from those of female. All four subapical setae of tarsi II–IV short, spine-like. Dorsal shield dimensions: holotype, length 348μ, width 181μ (range among six paratype specimens: length 336–360μ, width 175–185μ).

Female. Setae L2 and the nine pairs of sublateral setae all on lateral membrane. Ornamentation and other chaetotaxic characteristics of dorsal shield as on male. Peritrematal plates very near but not united anteriorly to dorsal shield; peritremes extending as far as three-fourths of distance from setae L1 to M1 of body dorsum (but varying in length on other specimens as on males). Pre-endopodal plates absent; sternal shield continuous anteriorly with presternal areas of sclerotization reaching anteriad to either side of base of tritosternum; no distinct anterior margin of sternal shield extending between first pair of sternal setae. Sternal shield ornamented only along lateral margins (and more faintly near middle on some specimens). Membranous cuticle posterior to epigynial shield with nine pairs of ventral setae. Anal shield ornamented, ovate in shape, about as broad as long; evenly rounded contour of anterolateral margins of anal shield distorted laterally by the protruding pair of lateral pores. Para-anal setae half as long as postanal seta.

Movable chela bidentate; fixed chela and other structures of gnathosoma like those of male. Dorsal shield dimensions: allotype, length 418μ, width 217μ (range among nineteen paratype specimens: length 381–439μ, width 198–228μ).

Holotype. Male, Barrow, Alaska, June 29, 1953 (P. D. Hurd, Jr.), from station II, site 7; type no. 2583 in U. S. National Museum.

Allotype. Female, Barrow, Alaska, August 25, 1953 (P. D. Hurd, Jr.), from station II, site 6; deposited in U. S. National Museum.

Paratypes. Seven males, twenty-four females, Barrow, Alaska (P. D. Hurd, Jr.); males and females collected from June 29 through August 25, 1953; specimens collected from station II, sites 5, 6, and 7.

The spermatophoral process of *A. minor* has a simple form resembling that of *A. ornatus*, but differing from the latter by being stouter and by lacking a distinct dorsal curvature beyond the tip of the movable chela.

5. *Arctoseius robustus*, new species

(Plates X; XI; XII; XIX, figs. 5, 6; XX, fig. 7)

Large size, the D9/D3 setal length ratio, the long peritremes, and the confluence of the sternal or sternogenital shield with presternal sclerotization are characteristics that aid in the recognition of both sexes of *Arctoseius robustus*. The most singular characteristic of each sex is the shape of the spermatophoral process of the male, and the subquadrate shape of the anal shield of the female.

Male. Dorsal shield well ornamented. Setae L2 and anteriormost two pairs of sublateral setae on margin of dorsal shield (but only L2 or L2 and S1 on dorsal shield of some specimens); remainder of the nine pairs of sublaterals, including S8 and S9, on lateral membrane. Setae of idiosomal dorsum moderately long; setae D9 and D10 only half as long as D3. Peritrematal plates fused anteriorly to dorsal shield. Peritremes long, extending onto areas above coxae I to the level of setae L1 (level varying from setae L1 to nearly one-half of distance from setae L1 to M1 on other specimens) of body dorsum. Pre-endopodal plates absent; sternogenital shield continuous anteriorly with areas of presternal sclerotization partially encircling the genital orifice; shield without distinct anterior margin between first sternal setae; margin distinct laterad of these setae. Sternogenital shield clearly ornamented along lateral margins from first to behind fourth pairs of sternal setae and on genital region; ornamentation light or indistinct on middle of shield between second and fourth pairs of sternal setae; shield constricted at level of coxae IV but genital setae on its posterolateral extremities. Endopodal plates fused to sternogenital shield between fourth sternal and genital pairs of setae. Ventrianal shield very heavily ornamented, broad, with six of the seven pairs of ventral setae in addition to the anal setae. Ventrianal shield reaching laterad beyond external margins of coxal cavities IV, covering areas occupied by metapodal plates. Position and outline of metapodals still visible through ventrianal shield. Para-anal setae less than half as long as postanal seta.

Corniculi about two-thirds as long as movable chelae. Movable chela unidentate; fixed chela quadridentate, with pilus dentilis on dentiform elevation. Spermatophoral process long and slender, straight and slightly tapering along most of the free part of its length but curving dorsally just before its anterior terminus. Leg II without setae differentiated from those of female. All four subapical setae of tarsi II–IV short, spine-like. Dorsal shield dimensions: holotype, length 518μ, width 270μ (range among eight paratype specimens: length $476–543\mu$, width $249–299\mu$).

Female. Ornamentation and chaetotaxy of dorsal shield as on male, except setae L2 and all nine pairs (some specimens with an additional pair variably placed on lateral membrane posterior to lateral incisions of dorsal shield) of sublateral setae on lateral membrane. Peritrematal plates not united anteriorly to dorsal shield; peritremes reaching as far as two-fifths of distance from setae L1 to M1 of body dorsum (but varying in length on other specimens as on males). Pre-endopodal plates absent; sternal shield continuous with presternal areas of sclerotization extending anteriad to

either side of base of tritosternum; anterior margin of shield indistinct or incomplete at level of first pair of sternal setae (and some specimens with an invaginated area of weaker sclerotization between the first sternal setae). Sternal shield ornamented over entire surface, but more faintly in center. Membranous cuticle posterior to epigynial shield with nine (eight on some specimens) pairs of ventral setae. Anal shield ornamented, slightly wider than long, its anterior and lateral margins flattened, giving shield a somewhat rectangular appearance; lateral margins of anal shield very slightly (or not at all on some specimens) distorted by lateral pores. Para-anal setae less than half as long as postanal seta.

Movable chela bidentate; fixed chela and other gnathosomal structures as in male. Dorsal shield dimensions: allotype, length 667μ, width 339μ (range among ten paratype specimens: length 587–736μ, width 307–362μ).

Holotype. Male, Barrow, Alaska, August 13, 1953 (P. D. Hurd, Jr.), from a miscellaneous "intermediate Berlese" sample; type no. 2584 in U. S. National Museum.

Allotype. Female, Barrow, Alaska, June 29, 1953 (P. D. Hurd, Jr.), from station II, site 6; deposited in U. S. National Museum.

Paratypes. Eight males, ten females, Barrow, Alaska (P. D. Hurd, Jr.); males collected from August 7 through August 24, 1953, and females collected from June 22 through August 24, 1953; specimens collected from station I, site 8, station II, sites 1, 2, 3, 5, and 6, station IV, sites 1, 2, 3, and 4, station V, sites 2, 6, 7, and 8.

The spermatophoral process of *A. robustus* is again of the simple type like those of *A. ornatus* and *A. minor*. It is distinguished by its comparatively sudden dorsal curvature at the distal end of an otherwise straight projection that is longer and more slender than those of the preceding two species.

Two of the female paratypes have structural variations worthy of note. One has an asymmetrically quadridentate tectum; one of the lateral tines is divided completely to its base. The other specimen has a plate of irregular outline in an asymmetrical position on the venter of the body. This plate is located anterolaterally from the anal shield and is so near to the shield as to bear one of the posteromedial preanal setae; the plate is about one-fourth as large in area as the anal shield.

6. *Arctoseius idiodactylus*, new species

(Plates XIII; XIV; XV; XIX, figs. 9, 10; XX, fig. 6; XXII, figs. 5, 6)

The extremely unique shape of the spermatophoral process immediately distinguishes the male, whereas the shape of the anal shield less distinctly characterizes the female of this species. The D9/D3 setal length ratio, the long peritremes, the absence of ornamentation on the center of the sternal or sternogenital shield, and the confluence of this shield with presternal sclerotization are features that aid in recognizing both sexes of *Arctoseius idiodactylus*.

Male. Dorsal shield ornamented. Setae L2 and anteriormost two pairs of sublateral setae on margin of dorsal shield (but only L2 or L2 and S1 on dorsal shield of some specimens); lateral membranous cuticle with remainder

of the nine pairs of sublateral setae, including S8 and S9. Setae of idiosomal dorsum of moderate length; setae D9 and D10 two-thirds (varying from one-half to two-thirds on other specimens) as long as D3. Peritrematal plates well united anteriorly with dorsal shield. Peritremes long, reaching almost to the level of setae L1 (level varying from setae L1 to one-half of distance from setae L1 to M1 on other specimens) of body dorsum. Pre-endopodal plates absent; sternogenital shield confluent anteriorly with presternal areas of sclerotization encircling the genital orifice; shield with distinct anterior margin only laterad of first pair of sternal setae. Sternogenital shield ornamented only along lateral margins; shield narrowed between coxae IV but with genital setae on its posterolateral corners. Endopodal plates united to sternogenital shield between fourth sternal and genital pairs of setae. Ventrianal shield well ornamented, wide, with six of the seven pairs of ventral setae as well as the anal setae. Ventrianal shield reaching laterally beyond external margins of coxal cavities IV and overrunning metapodal plates. Metapodals still discernible through ventrianal shield. Para-anal setae about half as long as postanal seta.

Corniculi about two-thirds as long as movable chelae. Movable chela unidentate; fixed chela quadridentate, with pilus dentilis elevated on small dentiform structure. Basal half of freely projecting portion of spermatophoral process conspicuously expanded laterally and ventrally, with its lateral surface flattened; process abruptly constricting just beyond tip of movable chela and continuing anteriad as a very slender structure, curving first lateroventrally, then distally straightening out of the lateral curve and recurving dorsally. Leg II without sexually differentiated setae. All four subapical setae of tarsi II–IV short, spine-like. Dorsal shield dimensions: holotype, length 402μ, width 185μ (range among twenty-three paratype specimens: length 370–403μ, width 169–201μ).

Female. Dorsal shield ornamentation and chaetotaxy like those of male except setae L2 along with all of the nine pairs of sublateral setae on lateral membrane. Peritrematal plates barely united (not united on some specimens) anteriorly to dorsal shield; peritremes extending as far as one-fourth of distance from setae L1 to M1 of body dorsum (varying in length among other specimens as on males). Pre-endopodal plates absent; sternal shield confluent with presternal areas of sclerotization extending anteriad to either side of base of tritosternum; no distinct anterior margin of shield extending between first pair of sternal setae. Sternal shield ornamented only along lateral margins. Membranous cuticle posterior to epigynial shield with nine pairs (rarely eight pairs on some specimens) of ventral setae. Anal shield ornamented, about as long as wide, with flattened lateral margins; lateral pores definitely disrupting the contour of lateral margins of anal shield. (Anal shield highly variable in form among other specimens, clearly longer than wide on some specimens, but wider than long on others; when wider than long, shield with lateral margins usually not flattened, and lateral pores usually not disrupting contour of margins.) Para-anal setae about half as long as postanal seta.

Movable chela bidentate; fixed chela and other structures of gnathosoma as in male. Dorsal shield dimensions: allotype, length 476μ, width 217μ

(range among forty-eight paratype specimens: length 424–524μ, width 190–244μ).

Holotype. Male, Barrow, Alaska, August 10, 1953 (P. D. Hurd, Jr.), from station IV, site 4; type no. 2585 in U. S. National Museum.

Allotype. Female, Barrow, Alaska, August 5, 1953 (P. D. Hurd, Jr.), from station II, site 3; deposited in U. S. National Museum.

Paratypes. Twenty-four males, fifty-two females, Barrow, Alaska (P. D. Hurd, Jr.); males collected from August 5 through August 25, 1953, and females collected from June 22 through August 25, 1953; specimens collected from station I, sites 1, 2, 3, and 4, station II, sites 1, 2, 3, and 4, station III, sites 5, 6, and 7, station IV, sites 3 and 4, station V, sites 2, 7, and 8, station VI.

The shape of the sternal, epigynial, and anal shields varies greatly among female paratypes. One paratype male has an asymmetrically bidentate tectum.

7. *Arctoseius confusus*, new species

(Plates XVI; XVII; XVIII; XIX, figs. 7, 8; XX, figs. 1, 3, 4, 5; XXI, figs. 5, 6, 7)

The shape of the spermatophoral process of the male, the shape of the anal shield of the female, and ornamentation of the entire surface of the sternal or sternogenital shield are the best characters for distinguishing *Arctoseius confusus* from other species of *Arctoseius* occurring in the Barrow area. As is the case with *A. minor, A. robustus,* and *A. idiodactylus,* the D9/D3 setal length ratio, the long peritremes, and the confluence of the sternal or sternogenital shield with presternal areas of sclerotization are additional characteristics helpful in the recognition of this species.

Male. Dorsal shield well ornamented. Second pair of lateral setae on lateral membrane (or on lateral margin of dorsal shield on some specimens); all nine pairs of sublateral setae, including S8 and S9, on lateral membrane. Setae of idiosomal dorsum moderately long; setae D9 and D10 three-fourths (varying from two-thirds to three-fourths on other specimens) as long as D3. Peritrematal plates not or barely united anteriorly with dorsal shield. Peritremes long, reaching onto areas above coxae I to a level one-fourth of distance from setae L1 to M1 (level varying from seta L1 to one-half of distance from L1 to M1 on other specimens) of body dorsum. Pre-endopodal plates absent; sternogenital shield continuous with presternal sclerotized areas partially encompassing the genital orifice; shield without distinct anterior margin between first pair of sternal setae. Sternogenital shield ornamented across entire surface; shield constricted between coxae IV but with genital setae on its posterolateral corners. Endopodal plates united to sternogenital shield between fourth sternal and genital pairs of setae. Ventrianal shield well ornamented, wide, with six of the seven pairs of ventral setae and with the anal setae. Ventrianal shield extending laterally beyond outer margins of coxal cavities IV and covering metapodal plates; metapodals still evident through ventrianal shield. Para-anal setae about half as long as postanal seta.

Corniculi two-thirds as long as movable chelae. Movable chela unidentate; fixed chela tridentate (bi- to quadridentate on some specimens) with pilus

dentilis on small dentiform protuberance. Spermatophoral process simple, tapered, bending slightly laterad at level of tip of movable chela, and curving dorsally just before its anterior terminus. Leg II without sexually modified setae. All four subapical setae of tarsi II-IV short, spine-like. Dorsal shield dimensions: holotype, length 423μ, width 196μ (range among eight paratype specimens: length 407–466μ, width 193–209μ).

Female. Dorsal shield ornamentation and chaetotaxy as on male, except seta L2 consistently on lateral membrane along with the nine pairs of sublateral setae. Peritrematal plates not united anteriorly to dorsal shield; peritremes reaching as far as two-fifths of distance from setae L1 to M1 of body dorsum (but varying in length on other specimens as on males). Pre-endopodal plates absent; sternal shield combined with presternal sclerotized areas reaching anteriad to either side of base of tritosternum; definite anterior margin of shield lacking between first pair of sternal setae. Sternal shield ornamented over entire surface. Epigynial shield conspicuously ornamented. Membranous cuticle posterior to epigynial shield with eight (nine on few specimens) pairs of ventral setae. Anal shield ornamented, elliptical in shape, wider than long, with evenly rounded margins; lateral pores not distorting lateral margins of anal shield. Para-anal setae about half as long as postanal seta.

Movable chela bidentate; fixed chela quadridentate; other gnathosomal structures like those of male. Dorsal shield dimensions: allotype, length 471μ, width 222μ (range among sixteen paratype specimens: length 471–529μ, width 217–254μ).

Holotype. Male, Barrow, Alaska, June 22, 1953 (P. D. Hurd, Jr.), from station I, site 3; type no. 2586 in U. S. National Museum.

Allotype. Female, Barrow, Alaska, June 29, 1953 (P. D. Hurd, Jr.), from station IV, site 3; deposited in U. S. National Museum.

Paratypes. Nine males, eighteen females, Barrow, Alaska (P. D. Hurd, Jr.), males and females collected from June 22 through August 25, 1953; specimens collected from station I, sites 1 and 3, station II, sites 5, 6, and 7, station IV, sites 3 and 4.

The spermatophoral process of *A. confusus* is of the simple type, but it can be recognized by the slight lateral bend about midway along its free length, and by its taper being completed well before the distal extremity of the process.

The allotype specimen possesses a variational peculiarity. The tectum is symmetrically bidentate, the median tine being absent. One paratype male also has such a symmetrically bidentate tectum. Another paratype male has a symmetrically quadridentate tectum, the median tine being completely divided to its base. A third paratype male has only one lateral tine of the tectum developed; the rest of the tectum has the anterior margin rounded and denticulate, similar to that of some species of *Proctolaelaps* Berlese.

Synonymic List of Species of Genus *Arctoseius*

The following list of the known species of the genus *Arctoseius* is essentially that of Evans (1958) supplemented with more recently described

species. Known distributions are indicated. The symbols denote whether one or both sexes have been included in the original or subsequent descriptions of the species.

Genus *Arctoseius* Thor, 1930

Arctoseius bicuspidatus Willmann, 1949. Bavaria.	♀
Tristomus butleri Hughes, 1948. Ireland.	♂♀
Lasioseius cetratus Sellnick, 1940.	♂♀
Syn.: *Arctoseius bispinatus* Weis-Fogh, 1947.	♀
Iceland, Europe, North America.	
Arctoseius confusus, n. sp. Alaska.	♂♀
Gamasellus (*Sessiluncus*) *eremita* Berlese, 1918.	♀
Syn.: *Arctoseius austriacus* Willmann, 1949. Italy, Austria.	♀
Arctoseius erlangensis Sellnick, 1958. Sweden.	♀
(A validation of a manuscript name of Hirschmann.)	
Arctoseius halophilus Willmann, 1949. Poland.	♀
Arctoseius idiodactylus, n. sp. Alaska.	♂♀
Arctoseius laterincisus Thor, 1930. Spitsbergen.	♂♀
Arctoseius ?laterincisus Haarlov, 1942, not Thor, 1930. Greenland	♀
Arctoseius limburgensis Nesbitt, 1954. Netherlands.	♀
Arctoseius longispinosus Hirschmann, in Sellnick, 1958. *Nomen nudum.*	–
Arctoseius magnanalis Evans, 1958. England.	♂♀
Arctoseius minor, n. sp. Alaska.	♂♀
Arctoseius multidentatus Evans, 1955. Alaska.	♂♀
Arctoseius oculatus Willmann, 1949. Austria.	♂♀
Arctoseius ornatus Evans, 1955. Alaska.	♂♀
Arctoseius pannonicus Willmann, 1949. Austria, England.	♀
Arctoseius pratensis Hirschmann, in Franz, 1954. *Nomen nudum.*	–
Arctoseius robustus, n. sp. Alaska.	♂♀
Laelaps (*Iphis*) *semiscissus* Berlese, 1892. Italy.	♀
Arctoseius weberi Evans, 1955. Alaska.	♂♀

SUMMARY

1. *Arctoseius* Thor is the only genus of terrestrial mites known to be represented by more than two species at Barrow, Alaska; seven species occur there.

2. Materials for the present study were from Berlese sample cores which were collected during the summer months of 1953. The Berlese extractions were taken primarily from six stations representing most of the local types of habitat at Barrow. Topographical, vegetational, and substrate characteristics of the six field stations and their included sites are described briefly.

3. Qualitative and quantitative analyses of *Arctoseius* mites found in early and late summer sub-series totaling 64 core samples from the six field stations are presented in tabular form. Additional qualitative data were acquired from studies of some 70 core samples. Marked bionomical and ecological differences between the species of *Arctoseius* are indicated by these data and are discussed.

4. Two different kinds of symbiotes were found associated with the *Arctoseius* mites. One is an internal parasite represented only by a spore stage.

This parasite is probably *Arctosporidium lucidum* Thor. The other organism is a cutaneous symbiote, a fungus of the order Laboulbeniales.

5. The genus *Arctoseius* Thor is characterized. A discussion of the type species, *Arctoseius laterincisus* Thor, contrasts the original description of Thor with a later description by Haarlov. The present author believes that Haarlov's description was based on a species other than *A. laterincisus* Thor.

6. A key, diagnoses, and illustrations are presented for the seven species of *Arctoseius*. The value of males for species identification is demonstrated.

7. Males of the following species are described for the first time: *Arctoseius multidentatus* Evans, *A. weberi* Evans, and *A. ornatus* Evans.

8. Males and females of the following new species are described: *Arctoseius minor, A. robustus, A. idiodactylus,* and *A. confusus.*

9. A synonymic list of the presently known species of the genus *Arctoseius* is presented.

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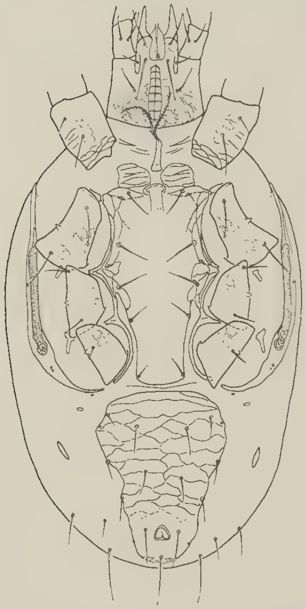

Plate I. *A. multidentatus,* male: body venter.

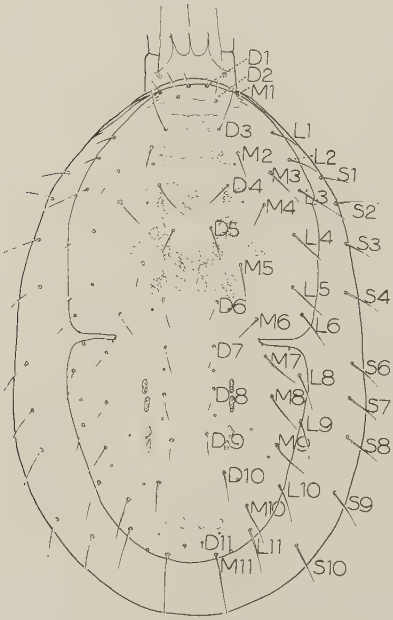

Plate II. *A. multidentatus,* female: body dorsum.

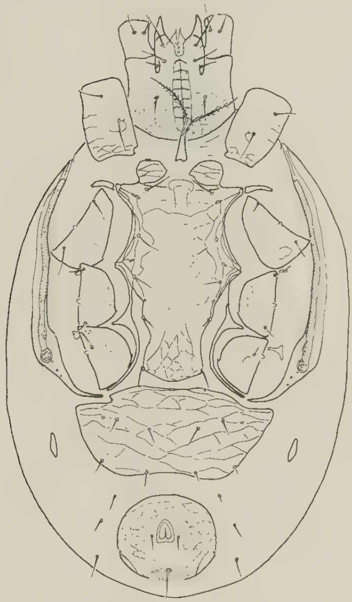

Plate III. *A. weberi,* male: body venter.

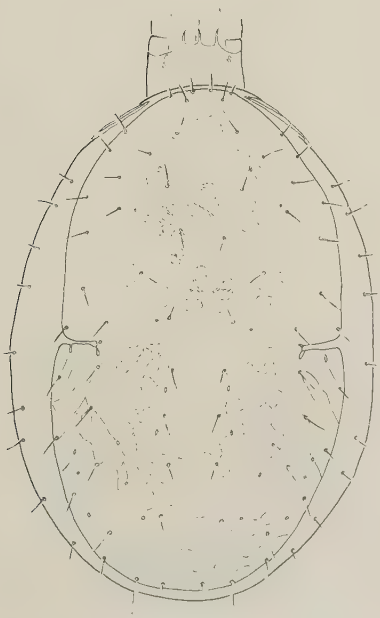

Plate IV. *A. weberi,* female: body dorsum.

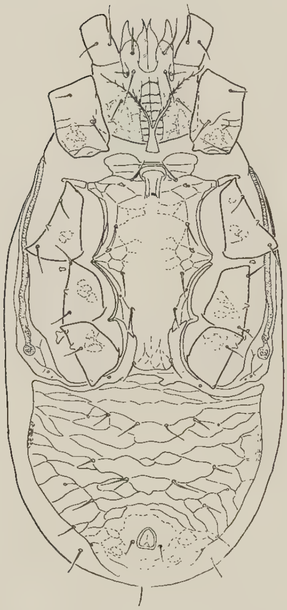

Plate V. *A. ornatus,* male: body venter.

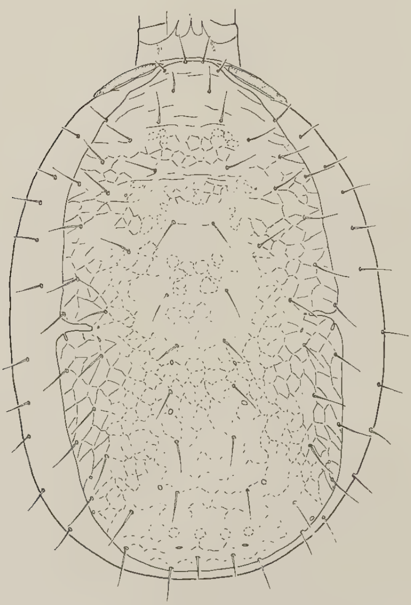

Plate VI. *A. ornatus,* female: body dorsum.

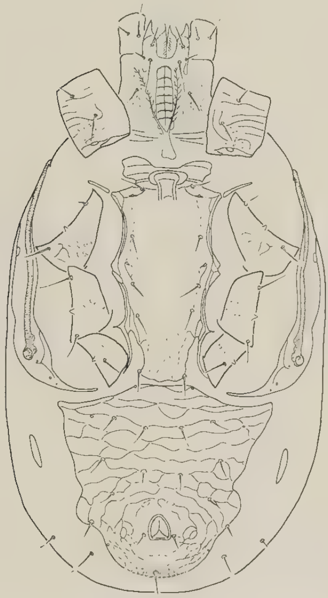

Plate VII. *A. minor,* male: body venter.

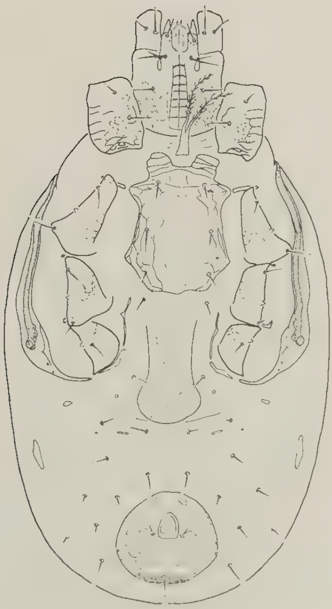

Plate VIII. *A. minor,* female: body venter.

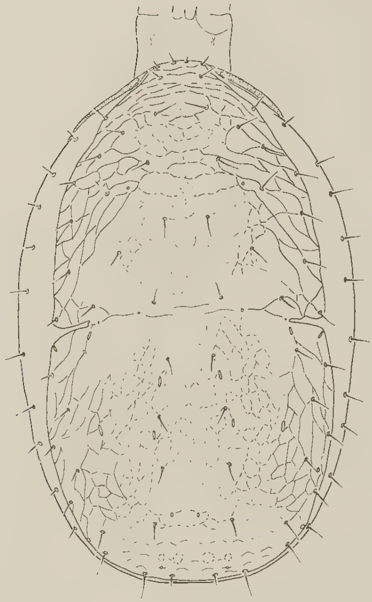

Plate IX. *A. minor,* female: body dorsum.

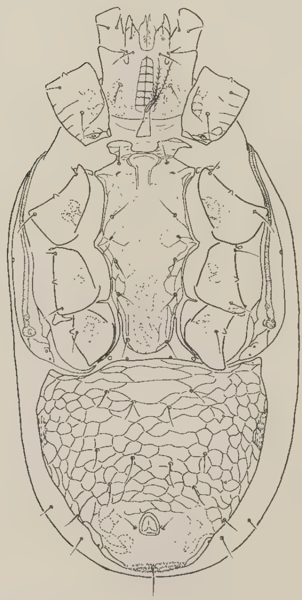

Plate X. *A. robustus,* male: body venter.

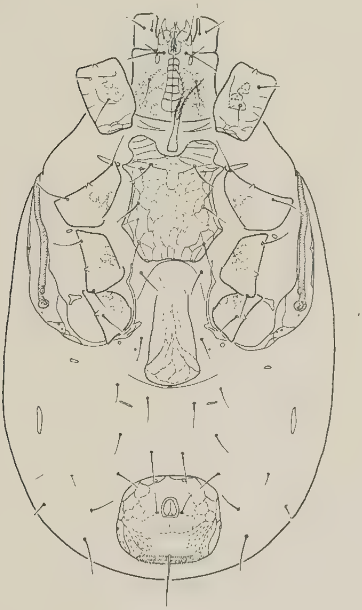

Plate XI. *A. robustus,* female: body venter.

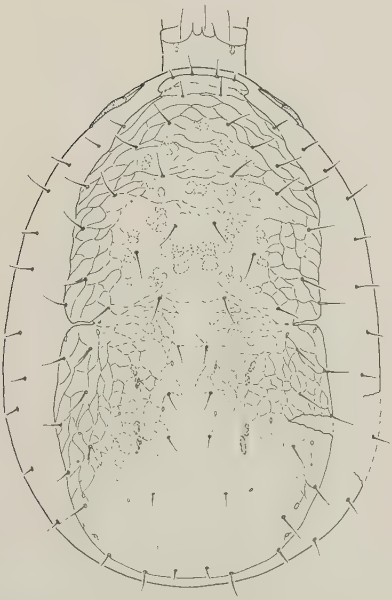

Plate XII. *A. robustus,* female: body dorsum.

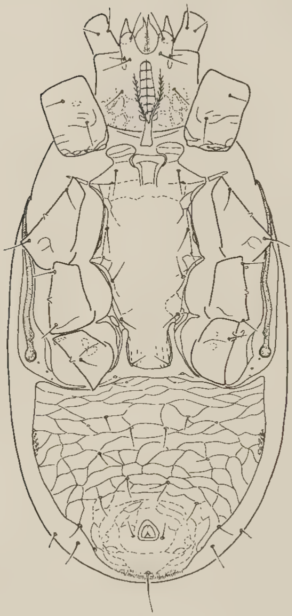

Plate XIII. *A. idiodactylus,* male: body venter.

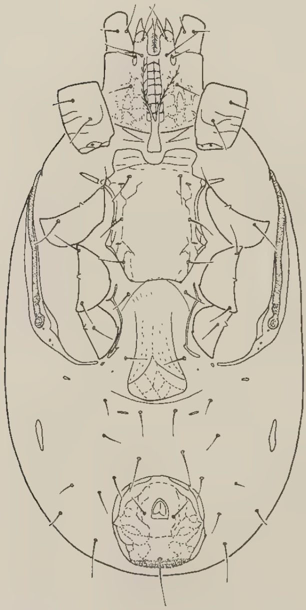

Plate XIV. *A. idiodactylus,* female: body venter.

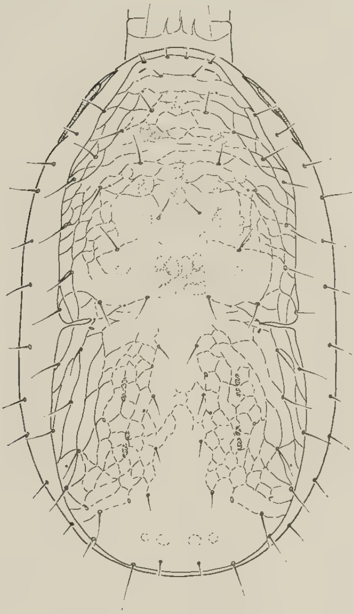

Plate XV. *A. idiodactylus*, female: body dorsum.

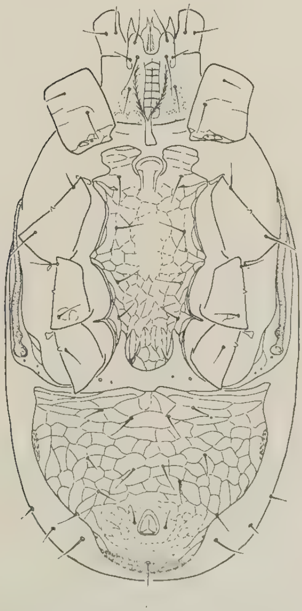

Plate XVI. *A. confusus*, male: body venter.

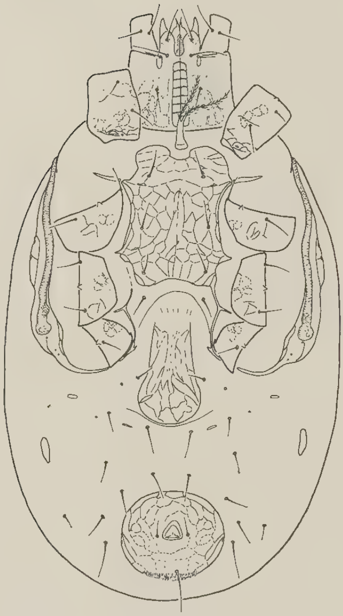

Plate XVII. *A. confusus,* female: body venter.

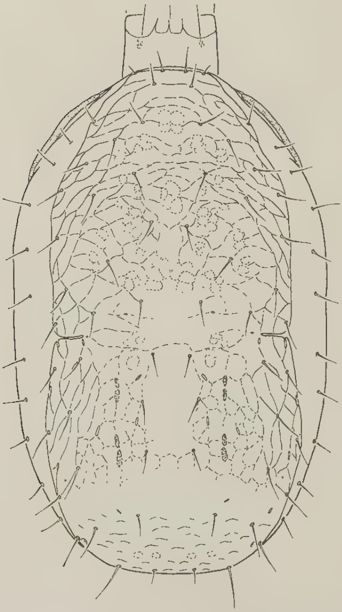

Plate XVIII. *A. confusus,* female: body dorsum.

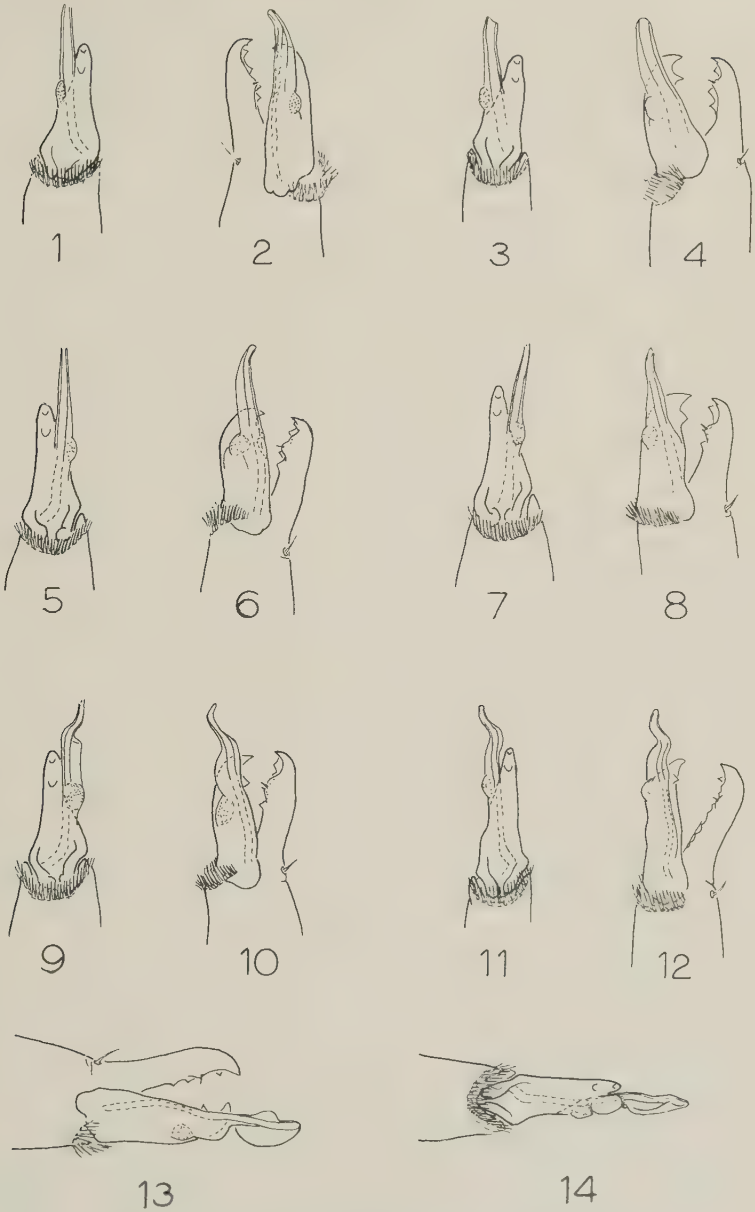

Plate XIX. Male spermatophoral processes of the seven species of *Arctoseius* from Barrow.

1, 2. *A. ornatus,* ventral and lateral views.
3, 4. *A. minor,* ventral and lateral views.
5, 6. *A. robustus,* ventral and lateral views.
7, 8. *A. confusus,* ventral and lateral views.
9, 10. *A. idiodactylus,* ventral and lateral views.
11, 12. *A. multidentatus,* ventral and lateral views.
13, 14. *A. weberi,* lateral and ventral views.

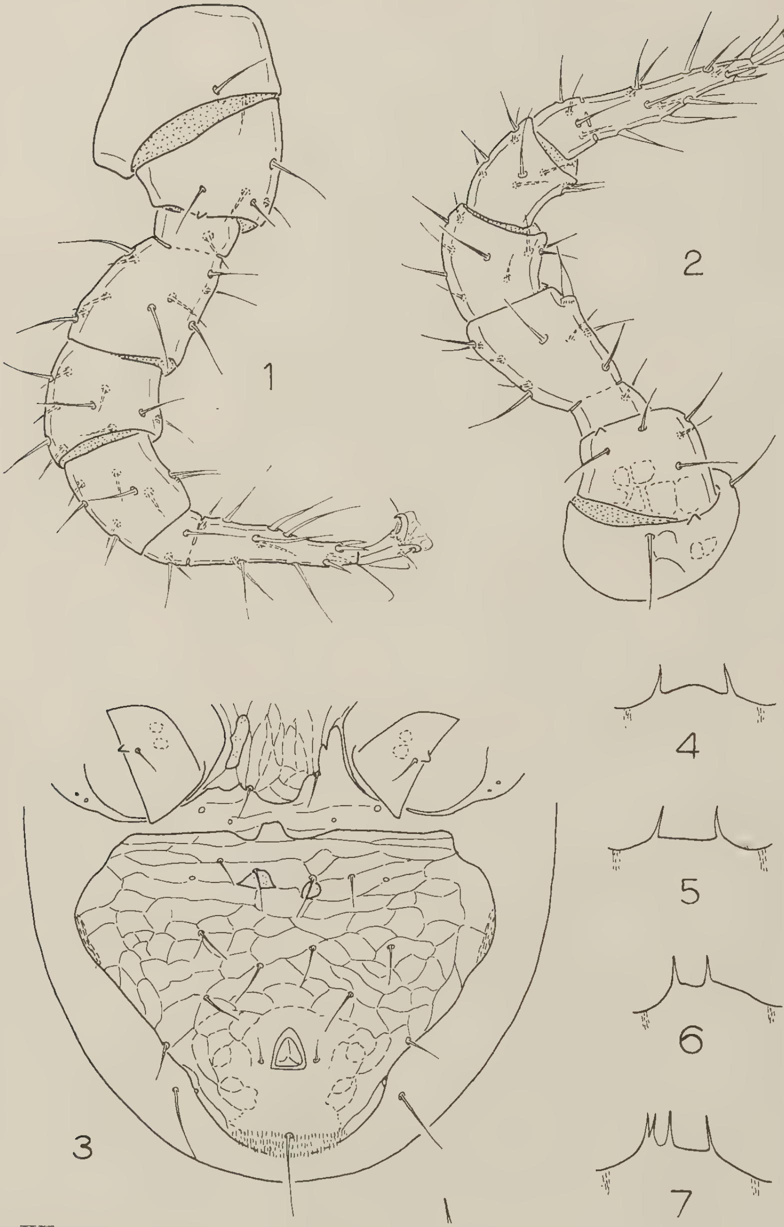

Plate XX.

1. *A. confusus,* male: leg II, lateral view.
2. *A. weberi,* male: leg II, lateral view.
3. *A. confusus,* male: partial view of body venter showing variation in shape of sterno-genital and ventrianal shields.
4. *A. confusus,* male: symmetrically bidentate tectum.
5. *A. confusus,* female: symmetrically bidentate tectum.
6. *A. idiodactylus,* male: asymmetrically bidentate tectum.
7. *A. robustus,* female: asymmetrically quadridentate tectum.

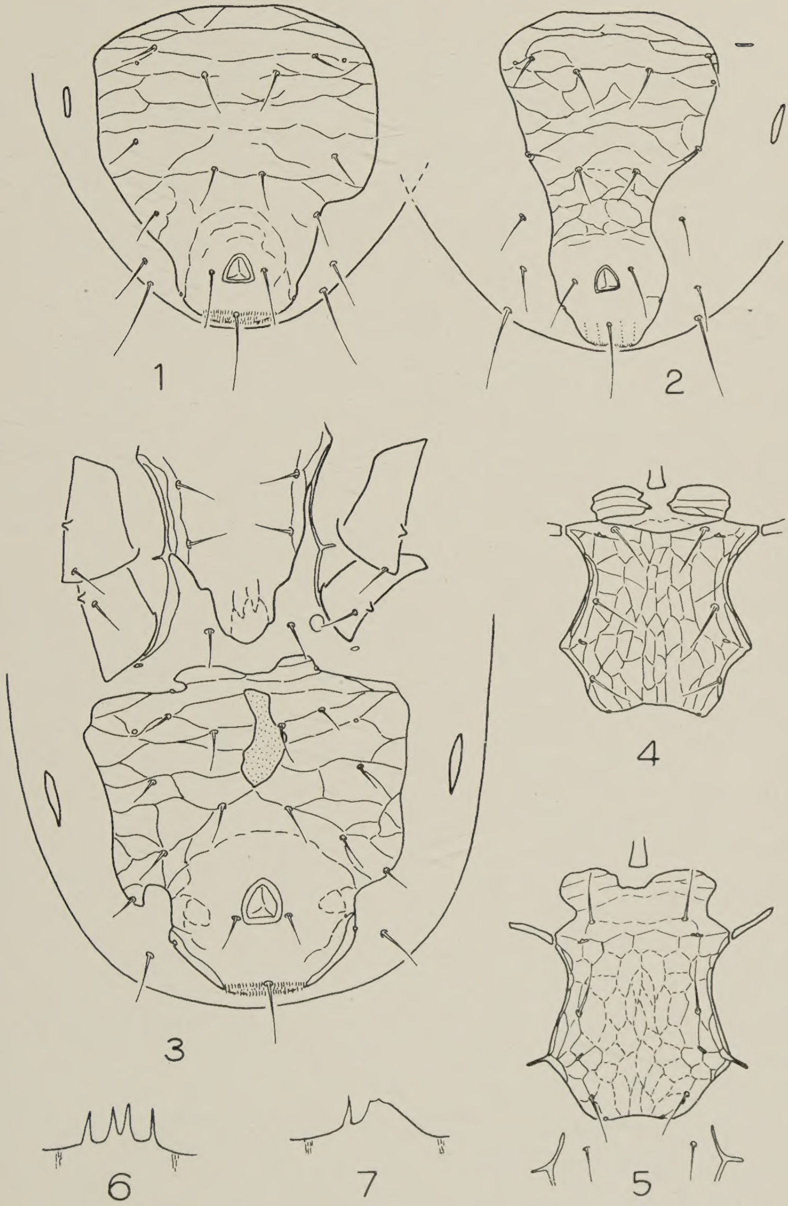

Plate XXI.

1, 2. *A. multidentatus,* male: variational shapes of ventrianal shield.

3. *A. minor,* male: partial view of body venter showing variation in shape of sternogenital and ventrianal shields.

4. *A. weberi,* female: sternal shield.

5. *A. confusus,* female: variation in shape of sternal shield.

6. *A. confusus,* male: symmetrically quadridentate tectum.

7. *A. confusus,* male: irregularly shaped tectum.

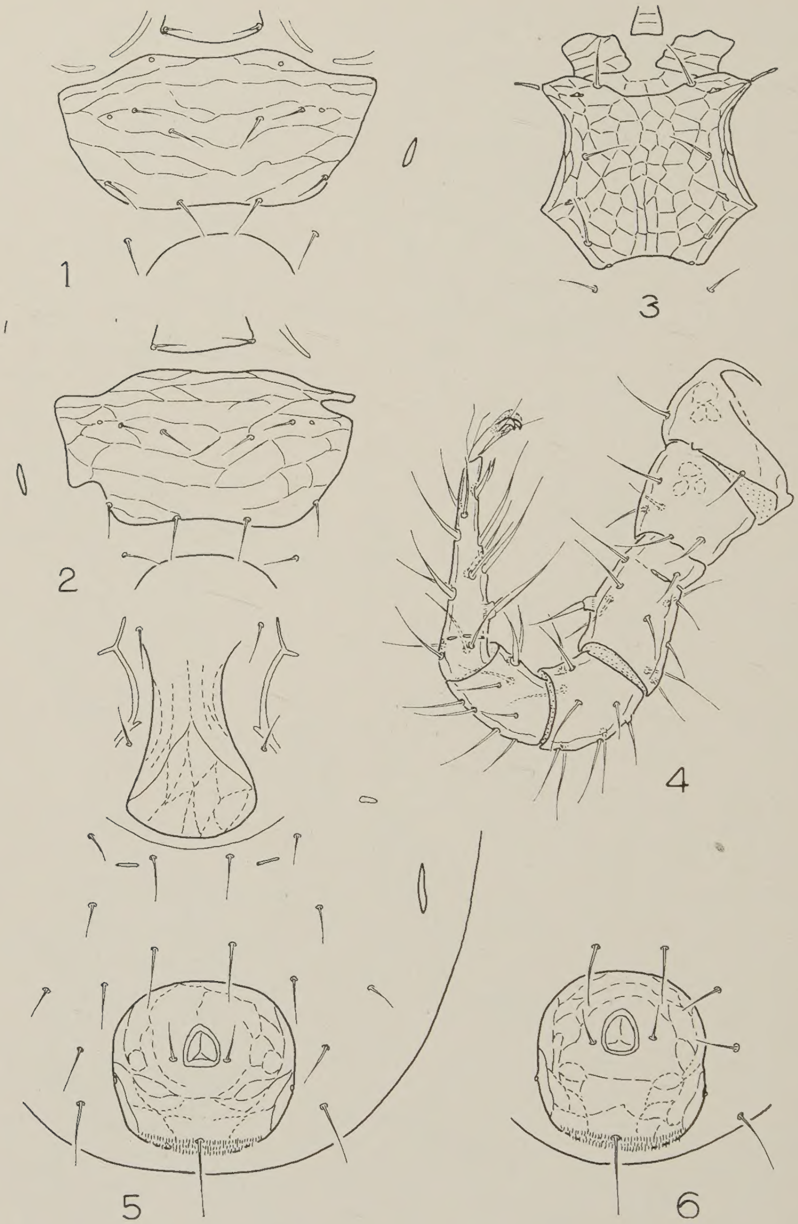

Plate XXII.

1, 2. *A. weberi,* male: variations in shape of ventral shield.
3. *A. ornatus,* female: sternal shield.
4. *A. multidentatus,* male: leg II, lateral view.
5. *A. idiodactylus,* female: partial view of body venter showing variation in shape of epigynial and anal shields.
6. *A. idiodactylus,* female: variation in shape of anal shield.

4*m*-1,'61(B3792)LS 141